JOURNAL
OF
AMERICAN CONCRETE INSTITUTE

VOL. III MARCH, 1915 No. 3

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William H. Ham
Robert W. Lesley
William K. Hatt
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Finance

Leonard C. Wason, *Chairman*
Robert W. Lesley
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PURPOSE OF THE INSTITUTE.

It is the purpose of the Institute, by means of conventions and publications, to increase and disseminate knowledge in regard to the use of cement, concrete and allied products; to conduct research into their properties and uses; and to formulate recommended practice and standard specifications.

Its objects are purely educational.

JOURNAL
OF
AMERICAN CONCRETE INSTITUTE

FOUNDED 1905, AND INCORPORATED 1906, AS
NATIONAL ASSOCIATION OF CEMENT USERS
CHARTER AMENDED JULY 2, 1913

The Institute is not responsible, as a body, for statements and opinions advanced in its publications

VOL. III MARCH, 1915 NO. 3

THE JOURNAL

This number of the JOURNAL inaugurates a new feature in connection with the Proceedings of the American Concrete Institute. Hereafter, no annual volume will be sent to the members, but the Proceedings of each Convention will appear in the current numbers of the JOURNAL immediately following the Convention. Libraries and other subscribers to these Proceedings will be furnished with an annual bound volume in lieu of the current JOURNALS upon request, but they will not receive both JOURNALS and annual volume without an additional payment. The matter is optional, and either the JOURNALS or the volume will be sent, as requested. The Proceedings of the Convention will appear serially in Part II of the JOURNAL, and the several numbers may be bound together to form a complete volume.

Another new feature will be the grouping of the papers on related topics; for example, the present and the next number deal with concrete roads; the succeeding number will deal with problems of the contractor; the next will contain papers on architectural topics, etc.

A further feature will be an editorial on some particularly important topic as occasion may arise.

THE TECHNICAL COMMITTEES

Attention is particularly called to the appeal of the Board of Direction for suggestions relative to committee work and the personnel of the Technical Committees. There is no question that the work of the Institute is largely dependent upon the activities of these committees, and will therefore be valuable in proportion as such activities are efficient.

Members of the Institute who would like to be identified with the work, or those who know men willing to serve on committees, should communicate with the officers of the Institute, and thus help them in the selection of the personnel of the committees. It is not to be expected that the Board of Direction can know all the members of the Institute, and their action in the appointment of these committees can be materially expedited and rendered more efficient through the co-operation of the members. It is hoped that every member will, therefore, take a personal interest in the matter and communicate his views to the Board as regards these Technical Committees.

THE WASON MEDAL

The Board of Direction will shortly appoint a committee to review the papers presented at the last Convention for the purpose of awarding the Leonard C. Wason Medal. This committee cannot begin its work until after the publication of the papers in their final form in the JOURNAL, and announcement will be made in the JOURNAL immediately after the award of the medal.

Attention is called to the fact that this medal is awarded for original papers and communications presented either at the Annual Convention or for publication in the JOURNAL. It is believed that this medal will provide a desirable stimulus for original contributions.

MEMBERSHIP

The activities and strength of the Institute increase in proportion to its membership. The importance and the high character of the work done by this Institute is reflected in the JOURNAL and the Standards thus far promulgated.

Each member should constitute himself a Committee on Membership. The officers cannot do all the work in developing the Institute. The members must bear their share.

Letter-Ballot on By-Laws and Specifications.

The following matters were referred to letter-ballot at the Chicago Convention:

1. Proposed Amendment to the By-Laws.

   Amend Article IV, Section 2, to read: The annual dues of each member shall be ten dollars ($10.00).

2. Proposed Standard Specifications for One Course Concrete Highway Pavement.

   The proposed Specifications appear in the JOURNAL, pp. 7–16, Vol. II, No. 6.

3. Proposed Standard Specifications for One Course Concrete Street Pavement.

   The proposed Specifications appear in the JOURNAL, pp. 17–26, Volume II, No. 6.

4. Proposed Standard Specifications for Two Course Concrete Street Pavement.

   The proposed Specifications appear in the JOURNAL, pp. 27–37, Vol. II, No. 6.

The following changes are common to the above mentioned Specifications:

In the paragraph "Joint Filler," when unprotected transverse joints are used, insert the words, "the width of the joint filler shall be at least ½ in. greater than the thickness of the pavement at any point."

The distance between transverse joints is changed from 35 ft. to 36 ft.

The time of mixing is changed from 45 seconds to 1 minute.

In paragraph "Finishing," insert the words "any holes left by removing any material or device used in constructing the joints, shall be filled with the same concrete that was used in the pavement."

5. Proposed Standard Specifications for One Course Concrete Alley Pavement.

   These Specifications are new and are printed on pp. 31–40 of this JOURNAL.

6. Proposed Revised Recommended Practice for Concrete Architectural Stone, Building Block and Brick.

   These were printed in the JOURNAL, Vol. III, No. 1.

7. Proposed Standard Specifications for Portland Cement Stucco on Wood Lath.

   These were printed in the JOURNAL, Vol. III, No. 1.

New Members.

The following new members have been elected:

ABBOTT, HAROLD C., Engineer, Bureau Concrete Extension, Lehigh Portland Cement Co., Consumers Bldg., Chicago, Ill.

BATTJES FUEL AND BLDG. MATERIAL CO., Jacob S. Westra, Secretary, 1575 S. Division Ave., Grand Rapids, Mich.

BAUMGARDNER CONCRETE PRODUCTS CO., 98 W. Market St., Tiffin, O.

BJORK, AUGUST E., Pres., Bjork Bros. Construction Co., 3811 Forrest Ave., Chicago, Ill.

BROWN, HAROLD P., 120 Liberty St., New York, N. Y.

BRUNER, L. A., Manager of Publicity, Canada Cement Co., Ltd., Herald Bldg., Montreal, Quebec.

BURNETT, SETH P., Superintendent, A. Gelinas & Sons, 521 Irving St., Saginaw, Mich.

BEST, BYRON G., Mining Engineer, Oliver Iron Mining Co., 225 Lowell St., Ironwood, Mich.

CARY, ELMER, Engineer, Clinton Wire Cloth Co., 342 River St., Chicago, Ill.

COPLAY CEMENT MFG. CO., W. G. Dutton, Sales Manager, 1106 Land Title Bldg., Phila., Pa.

ELLENDT, JOHN G., Contracting Engineer, Chamber of Commerce Bldg., Rochester, N. Y.

DE TONGH, JUAN ISIDOR, Consul of the Netherlands for Republic of Guatemala, 5 Avenua, Sur No. 9, Guatemala City, Guatemala.

FURBER, PIERCE P., District Engineer, C. A. P. Turner, 8 S. Dearborn St., Chicago, Ill.

GIBSON, THOMAS F., Designer, Southern Power Co., 602 Trust Bldg., Charlotte, N. C.

HOOVER, ANDREW P., Engineer, John W. Ferguson Co., 152 Market St., Paterson, N. J.

HUBBELL, CHAS. H., President and General Manager, Hubbell Construction Co., 209 Security Bldg., Davenport, Iowa.

JONES, FRANK R., Engineer, Wilder & Wight, Architects, 400 First Nat'l Bank Bldg., Kansas City, Mo.

MONKS & JOHNSON, Engineers and Architects, 78 Devonshire St., Boston, Mass.

MUELLER, JOHN W., Civil Engineer, Rooms 9–11 Colonial Bldg., Box 112, Newcastle, Ind.

NEW JERSEY ZINC CO., THE (OF PA.), Francis P. Sinn, Superintendent, Palmerton, Pa.

WHITNEY, HARLAN K., Civil Engineer, 304 Ward Bldg., Battle Creek, Mich.

ZEIDLER, JOHN L., Pres., Zeidler Concrete Pipe Co., 401 Francis St., St. Joseph, Mo.

Reduced Prices for Back Volumes.

Members of the Institute can obtain copies of back publications at the following special prices:

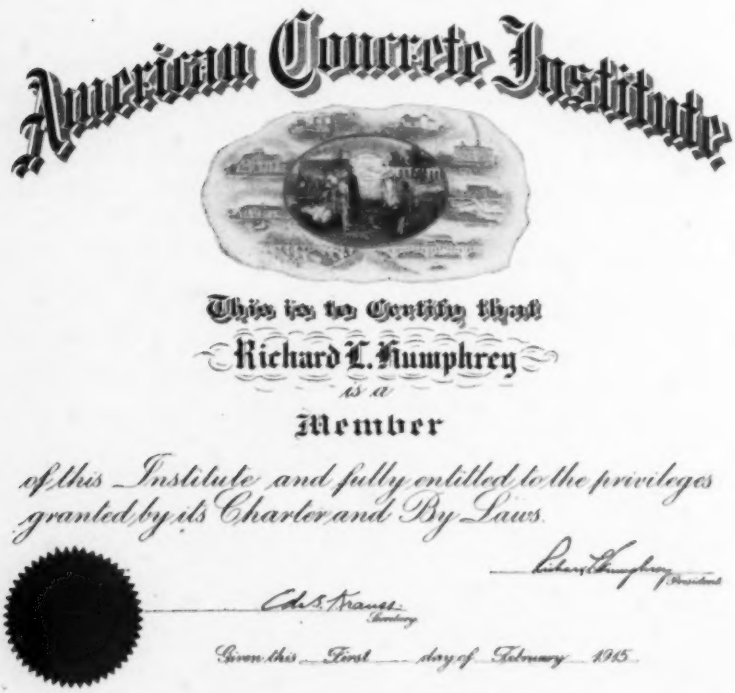
Vol. I, 50 cents; Vols. II to VI, $1.50 each; all in paper binding. For cloth or half morocco binding there is an additional charge per volume of 50 cents or $1.00 respectively. Vol. VII is available only in cloth binding, $2.00, or half morocco, $2.50.

Membership Certificate.

A Certificate of Membership in this Institute will be furnished to any member in good standing, i. e., whose dues are paid up to date. These Certificates are printed from an engraved steel plate. The name of the member is engrossed and the Certificate will be signed by the President and Secretary. The Certificates are about 10 x 14 ins., and have sufficient margin to be framed 14 x 17 ins. They are engraved on parchment or parchment paper, both suitable for rolling or framing.

The charge for certificates is as follows:

Parchment	$2.50
Parchment Paper	1.50


American Concrete Institute
This is to Certify that
Richard L. Humphrey
is a
Member
of this Institute and fully entitled to the privileges granted by its Charter and By-Laws.
Given this First day of February 1915

MEMBERSHIP CERTIFICATE.

Standards Adopted by the Institute.

1. Standard Specifications for Cement with Appendix on Standard Methods of Testing and Chemical Analysis, 23 pp.
2. Standard Specifications for Portland Cement Sidewalks, 6 pp.
4. Standard Building Regulations for the Use of Reinforced Concrete, 13 pp.
5. Standard Specifications for One Course Concrete Highway, 10 pp.
6. Standard Specifications for Portland Cement Curb and Gutter, 7 pp.
7. Standard Recommended Practice for the Use of Reinforced Concrete, 21 pp.
8. Standard Specifications for Scrubbed Concrete Surfaces, 3 pp.
9. Standard Recommended Practice for Concrete Drain Tile, 3 pp.
10. Standard Recommended Practice for Concrete Architectural Stone, Building Block and Brick, 4 pp.
11. Standard Specifications for Concrete Architectural Stone, Building Block and Brick, 3 pp.
12. Standard Building Regulations for the Use of Concrete Architectural Stone, Building Block and Brick, 3 pp.
13. Standard Specifications for Plain Concrete Floors, 6 pp.
14. Standard Specifications for Reinforced Concrete Floors, 5 pp.
15. Standard Specifications for Portland Cement Stucco on Metal Lath, Brick, Tile or Concrete Block, 9 pp.
16. Standard Methods for the Measurement of Concrete Work, 7 pp.
17. Standard Specifications for One Course Concrete Street Pavement, 10 pp.
18. Standard Specifications for Two Course Concrete Street Pavement, 11 pp.
19. Standard Specifications for One Course Concrete Alley Pavement.

The above Standards can be obtained at the price of 25 cents each or in lots of ten or more at 20 cents each. Special price to Members 15 cents or 10 cents each in lots of ten.

Report of the Board of Direction

PRESENTED AT THE ELEVENTH ANNUAL CONVENTION.

Your Board of Direction presents herewith the following report on the condition of the affairs of the Institute:

Meetings.—Since the last Convention, the Board of Direction has held four meetings and the Executive Committee has had many conferences to carry on the work of the Institute. An abstract of the minutes of these meetings is appended.

Membership.—The membership at the close of the last Convention was 891. Since that time 18 new members have been added, and three members, F. Henry Dumary, A. F. Gerstell and George C. Walters, have died; the present membership is 907.

The Board regrets especially to record the loss of one of its former members, Mr. George C. Walters. Mr. Walters was a man of lovable disposition, a quiet worker, a most loyal supporter of the Institute, and his loss will be felt in the council of its affairs.

Report of the Treasurer.—

RECEIPTS.

Balance, July 1, 1913			$94.32
Dues: 1911	$15.00		
1912	240.00		
1913	2,341.80		
1914	30.00		
		$2,626.80	
Publications: Sales of Proceedings	$194.30		
Sales of Standards	77.05		
Sales of Journal	18.20		
		289.55	
Convention at Chicago		1,000.00	
Subscriptions		900.00	
Interest on deposits		4.68	
Miscellaneous		1.67	
Total Receipts			4,822.70
			$4,917.02

DISBURSEMENTS.

Salaries	$2,700.00	
Office rent	720.00	
Postage, printing, stationery, etc	386.39	
Board meetings	5.50	
Publications	397.34	
Convention at Chicago	428.34	
Committees	4.90	
Miscellaneous	14.50	
Research	218.38	
Total Disbursements	$4,875.35	
Balance, June 30, 1914	41.67	
		$4,917.02

PHILADELPHIA, 8th February, 1915.

We hereby certify that we have audited the Cash Receipts and Disbursements of the Treasurer of the American Concrete Institute for the year ended 30th June, 1914, and found that the dues collected and receipts from the sales of publications, etc., as they appear on the Cash-book have been properly accounted for and that all disbursements were substantiated by vouchers.

The foregoing report of the Treasurer is in agreement with the Cash-book.

LYBRAND, ROSS BROS. & MONTGOMERY,
Certified Public Accountants.

Proceedings.—The proceedings of the Kansas City Convention (Volume VIII) have been published and distributed. The proceedings of the Pittsburg Convention (Volume IX) have been published in part in Journals 1, 2 and 3, of Volume I, and the remainder will be in press soon. The proceedings of the last Convention (Volume X) are being printed in seven Journals (Volume II) of 1914. In addition to this, Journals for January and February of this year have been issued, in which are published the advance reports and papers for this Convention.

Hereafter the proceedings of the Annual Conventions, and the work of the Institute and its Committees, will be issued in the Journal, and there will not be an annual volume of proceedings published, as these will be contained in Part II of the Journal.

Income and Expenses.—Your Board was confronted with the fact that the income from membership dues was insufficient to meet, not only the outstanding obligations, but also to properly conduct the affairs of the Institute along the adopted lines. It

found that to continue the work of the Institute, and meet these obligations, it would be necessary to raise the required money by subscription, and with this end in view it prepared a budget for the present fiscal year, outlining a definite plan for financing the Institute. The budget involved the necessary expenditure of a total of $12,088.00 above the possible income from dues and all other sources. And under this plan it was proposed that a Secretary be selected who could devote his entire time to the work of the Institute. The money required had to be raised by subscriptions.

Your Board is very much pleased to report that through the efforts of Mr. Humphrey the sum of $17,450.00 has been subscribed to date by parties who consider the Institute valuable to their interests, and a list of these subscribers is attached hereto. Of this subscribed amount more than $12,000.00 has been paid into the Treasury of the Institute, and it is naturally expected that the balance will be received within the next thirty days. The success of this plan has made possible the fulfilling of the Institute's obligations to its members, and we believe it now enters on a period of greater efficiency by reason of its present financial condition. It is, however, the desire of the Board, because of the fact that it is evident that the $5.00 dues are not sufficient to sustain the operations of the Institute, that these dues be raised to $10.00, and it is now the duty of every member not only to become active in the affairs of the Institute, but to assist in raising its membership to a number that will make it self-sustaining.

The thanks of the Institute should be extended to all those through whose generous subscription this financial condition has been made possible, and the past difficulties confronting the Institute have been overcome.

Edison Fire.—On account of the widespread effect of the fire that occurred in the buildings of Thomas A. Edison, Inc., at Orange, N. J., a number of which were of reinforced concrete, it was considered advisable by the Executive Board to take immediate action and unusual steps to select a committee of such prominence to report on this fire that its report would be accepted as impartial and authoritative; therefore, the following committee was appointed and its very able report will be presented at this Convention.

Research Work.—During the past year a number of columns

were tested on behalf of the Institute to determine the best method of reinforcement, and a committee has been appointed to look further into the subject and report a program for future investigation by the Institute.

Medals.—It was believed by the Board that the quality of papers presented, and interest in the Institute work will be stimulated by offering a medal annually for the best paper published during the year, and for the best results obtained from original research work, and the Board is very glad that such a medal has been donated. Success is in the hands of the membership.

SUBSCRIBERS TO THE FUND TO FINANCE THE AMERICAN CONCRETE INSTITUTE.

Aberthaw Construction Company.
Alpha Portland Cement Company.
Alsens Portland Cement Works.
Allentown Portland Cement Company.
American Cement Tile Manufacturing Company.
American Steel & Wire Company.
Asbestos Protected Metal Company.
Ashgrove Portland Cement Company.
Atlas Portland Cement Company.
Barrett Manufacturing Company.
Bath Portland Cement Company.
Blaw Steel Construction Company.
Buffalo Steel Company.
Burt Portland Cement Company.
Calumet Steel Company.
Canada Cement Company, Ltd.
Cape Girardeau Portland Cement Company.
Carnegie Steel Company.
Chicago Portland Cement Company.
Clinchfield Portland Cement Company.
Concrete Steel Company.
Coplay Cement Manufacturing Company.
Crescent Portland Cement Company.
Dewey Portland Cement Company.
Dexter Portland Cement Company.
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Municipal Engineering & Contracting Company.
Nazareth Portland Cement Company.
New Aetna Portland Cement Company.
Newaygo Portland Cement Company.
Northwestern Expanded Metal Company.
Ogden Portland Cement Company.
Ottawa Silica Company.
Peerless Portland Cement Company.
Peninsular Portland Cement Company.
Penn-Allen Portland Cement Company.
Pennsylvania Cement Company.
Phoenix Portland Cement Company.
Pittsburgh Testing Laboratory.
Raymond Concrete Pile Company.
Riverside Portland Cement Company.
R. W. Hunt & Company.
Samuel Cabot, Inc.
Sandusky Portland Cement Company.
Security Cement & Lime Company.
St. Louis Portland Cement Company.
Tidewater Portland Cement Company.
Toch Bros.
Trussed Concrete Steel Company.
Turner Construction Company.
Universal Portland Cement Company.
Virginia Portland Cement Company.
Vulcanite Portland Cement Company.
Wabash Portland Cement Company.
Whitehall Portland Cement Company.
Wolverine Portland Cement Company.

APPENDIX.

Abstract of Minutes of Meetings of the Board of Direction

ABSTRACT OF MEETING OF THE BOARD OF DIRECTION, HELD FEBRUARY 20, 1914, AT 4.50 P. M., AT THE AUDITORIUM HOTEL, CHICAGO, ILL.

Present: Richard L. Humphrey, President; Arthur N. Talbot and Leonard C. Wason, Vice-Presidents; Benjamin F. Affleck, Edward D. Boyer, Directors; and Edward E. Krauss, Secretary.

The Board of Direction authorized the payment of the bill of Arthur W. Kelly, of $201.75, covering the stenographic report of the Pittsburgh Convention.

The appointment of an Executive Committee and Committees on Finance, Medals and Publications was deferred until the meeting of the Board of Direction to be held March 19, 1914, at 10 A. M., at the Auditorium Hotel.

The Board authorized the publication of the Proceedings of the Chicago Convention in Part II of the JOURNAL.

ABSTRACT OF MEETING OF THE BOARD OF DIRECTION, HELD MARCH 19, 1914, AT THE AUDITORIUM HOTEL, CHICAGO, ILL.

Present: Richard L. Humphrey, President; Arthur N. Talbot and Leonard C. Wason, Vice-Presidents; Edward D. Boyer, Director; and Robert A. Cummings, Treasurer.

The President presented the following letter from Edward M. Hagar, which he had acknowledged; no action was taken in the matter:

CHICAGO, March 9, 1914.

My dear Mr. Humphrey:

There has been so much adverse criticism arising from a misunderstanding of my motives in offering to accept the responsibility for the management of the American Concrete Institute, with the appointment of one of our employees as Secretary, that I wish to withdraw my suggestions in this regard.

We have the best interests of the Institute at heart and would not want to be parties to any arrangement that did not have the full support of practically the entire membership.

Yours very truly,

(Signed) EDWARD M. HAGAR,
President.

MR. RICHARD L. HUMPHREY,
President, American Concrete Institute,
Philadelphia, Pa.

The report of the Finance Committee was read in detail, and the question of finances thoroughly discussed.

The report of the Finance Committee was accepted.

The Board approved the act of the President in collecting and disbursing subscriptions on account of the finances of the American Concrete Institute.

The Board ordered that all issues of the JOURNAL should contain a price list for the sale of publications, a list of standards and a membership blank.

It was agreed that the representative of each district should personally interview members of the Institute in his territory who were delinquent in dues.

The President was authorized to appoint a Committee on Membership.

The following committees were appointed:

Executive Committee:

Richard L. Humphrey, Chairman,
Leonard C. Wason,
Edward D. Boyer,
Edward E. Krauss,
Robert A. Cummings.

Committee on Finance:

Leonard C. Wason, Chairman,
Edward D. Boyer,
Robert A. Cummings.

Committee of Publications:

Arthur N. Talbot, Chairman,
Leonard C. Wason,
Robert W. Lesley,
Robert A. Cummings,
Richard L. Humphrey,
Edward E. Krauss.

Committee on Papers and Program:

Richard L. Humphrey, Chairman,
Allen Brett,
E. J. Mehren,
Frank C. Wight,
Rudolph J. Wig,
Sanford E. Thompson,
C. W. Boynton,
Cloyd M. Chapman,
W. P. Anderson,
George C. Walters,
John B. Leonard,
E. S. Hanson,
F. K. Irvine.

It was decided to discontinue the Committee on Education.

The reprinting of Mr. J. C. Pearson's paper by various parties was authorized, provided proper acknowledgment is given the Institute.

ABSTRACT OF MEETING OF THE BOARD OF DIRECTION, HELD OCTOBER 8, 1914, AT THE HOUSE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, 220 WEST FIFTY-SEVENTH STREET, NEW YORK, N. Y.

Present: Richard L. Humphrey, President; Leonard C. Wason, Vice-President; Robert A. Cummings, Treasurer; and Edward D. Boyer, Robert W. Lesley and Henry C. Turner, Directors.

A communication from the Chairman of the Committee on Specifications and Methods of Tests for Concrete Materials in regard to the change of name of the Committee was considered, and it was decided highly desirable that the title should be "Committee on Concrete Aggregates."

The following Committee on Medals was appointed:

Arthur N. Talbot,
Robert W. Lesley,
Richard L. Humphrey, Chairman.

The resignation of Benjamin F. Affleck as Director was accepted with an expression of the appreciation of the Board of his valuable services and of his interest and co-operation in the work of the Institute, which have contributed so much to its success. William K. Hatt was elected to fill the vacancy.

The resignation of W. L. Church as Director was accepted and Henry C. Turner elected to fill the vacancy.

The President made a report on the result of his efforts to raise $15,000 to carry out the plan for financing the Institute, and on his recommendation the Board authorized him to issue a call as soon as $12,000 was actually subscribed.

The following resolution was unanimously adopted:

"WHEREAS, The statement of the President as to the subscriptions to the fund to finance the Institute was so favorable as to lead to the belief that considerable more than the amount required by the Budget would be received, be it

Resolved, that the President be, and is hereby authorized to continue his endeavors in soliciting subscriptions, and that he be reimbursed for his expenses in connection therewith."

An audit of the accounts for the year ending June 30, 1914, was authorized.

The President was authorized to arrange for the next Convention to be held at Chicago, preferably at the time of the Cement Show.

It was decided to issue a JOURNAL on the 1st of November to contain the announcement of the time and place of the Annual Convention, a tentative program, a letter ballot of specifications and By-Laws, and a canvass for members of the Nominating Committee.

ABSTRACT OF MEETING OF THE EXECUTIVE COMMITTEE, HELD DECEMBER 3, 1914, AT THE HOUSE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, 220 WEST FIFTY-SEVENTH STREET, NEW YORK, N. Y.

Present: Richard L. Humphrey, President; Leonard C. Wason, Vice-President; Edward D. Boyer, Director; Robert A. Cummings, Treasurer; and Edward E. Krauss, Secretary.

It was decided to recommend to the Board of Direction an amendment to the By-Laws increasing the annual dues from $5.00 to $10.00.

It was decided to appoint the following Committee on Nomination of Officers, to become effective December 10th:

Frank C. Wight, New York, N. Y.
Alternate, E. S. Hanson, Chicago, Ill.
B. F. Affleck, Chicago, Ill.
Alternate, F. L. Williamson, Kansas City.
B. S. Pease, Chicago, Ill.
Alternate, A. E. Lindau, Chicago, Ill.
Rudolph J. Wig, Washington, D. C.
Alternate, A. R. Lord, Chicago, Ill.
Charles D. Watson, St. Louis, Mo.
Alternate, J. E. Conzelman, Philadelphia, Pa.

The President presented a bill of $50.00 for services in connection with the Trunk Line Suit of John S. Adams, attorney representing the interests of the Institute. The President was directed to take up the payment of this bill with the Cement Products Exhibition Company, which had agreed to protect the Institute from all liabilities on account of reduced rates to the New York Convention.

The resignation of Edward D. Boyer from the Finance Committee was accepted, and Henry C. Turner elected to fill the vacancy.

The President reported that considerably over $12,000 required had been subscribed, and $6,000 actually paid in.

It was decided that all bills covering the expenditures authorized by the Budget for the year 1914–15 attached to the subscription list, should be approved by the Finance Committee.

It was decided that the outstanding bills as listed in the Budget attached to the subscription fund, should be paid as soon as funds are available.

The President called attention to the fact that the American Society of Testing Materials had classified the Institute as a "producer" in its list of Committee members. It was the sense of the Executive Committee that the Institute should be classified as a "non-producer," and if this classification was not approved by the Society, it should withdraw its representation.

The recommendation of the Finance Committee to discontinue the bond of the Treasurer and reduce that of the Secretary to $2,500 was approved.

The following committees were appointed:

Reinforced Concrete Chimneys. William K. Hatt, Chairman.

Cement Roofing Tile.

Concrete Roads. A. N. Johnson was appointed Chairman in place of C. W. Boynton.

Banquet. Robert A. Hall was appointed Chairman of the Banquet of the Eleventh Convention.

The President presented the resignation of the Secretary. It was decided to recommend to the Board of Direction that it be accepted to take effect at the close of the Eleventh Convention.

The question of exchanges was referred with power to the Committee on Publications.

One Hundred Dollars was appropriated for the printing and distribution of condensed programs of the Convention.

ABSTRACT OF MEETING OF EXECUTIVE COMMITTEE, HELD DECEMBER 21, 1914, AT 10.30 A. M. AT THE HOTEL MANHATTAN, NEW YORK, N. Y.

Present: Richard L. Humphrey, President; Leonard C. Wason, Vice-President; Edward D. Boyer, Henry C. Turner, Directors; and Edward E. Krauss, Secretary.

The committee interviewed candidates for the Secretaryship of the Institute and selected a number of them to appear before the Board of Direction.

The meeting adjourned at 12.45 P. M.

ABSTRACT OF MEETING OF BOARD OF DIRECTION, HELD DECEMBER 21, 1914, AT 2.30 P. M., AT THE HOTEL MANHATTAN, NEW YORK, N. Y.

Present: Richard L. Humphrey, President; Leonard C. Wason, Vice-President; Edward D. Boyer, Robert W. Lesley, Henry C. Turner, Directors; and Edward E. Krauss, Secretary.

The minutes of the meeting of the Executive Committee, held on December 3, 1914, were approved.

The Board authorized the printing and distributing of 100,000 copies of the complete program of the Convention, the cost not to exceed $300.

It was decided that each visitor attending the Convention should register and receive a badge.

The action of the President in appointing the following Committee on Edison Fire was approved:

Cass Gilbert, Chairman, Architect, New York, N. Y.
E. J. Moore, Secretary, Engineer, New York, N. Y.
Walter Cook, Architect, New York, N. Y.
James Knox Taylor, formerly U. S. Supervising Architect, Philadelphia, Pa.
Charles L. Norton, Massachusetts Institute of Technology, Boston, Mass.
Rudolph P. Miller, Building Department, New York, N. Y.
William H. Ham, Engineer, Boston, Mass.
Richard L. Humphrey.

The meeting adjourned at 10.30 P. M.

ABSTRACT OF MEETING OF THE BOARD OF DIRECTION, HELD FEBRUARY 9, 1915, AT 6.10 P. M., AT THE AUDITORIUM HOTEL, CHICAGO, ILL.

Present: Richard L. Humphrey, President; Leonard C. Wason, Vice-President; William P. Anderson, Edward D. Boyer, and Henry C. Turner, Directors; Edward E. Krauss, Secretary; and C. L. Fish, Assistant Secretay.

President Humphrey presented a report, giving the names of the subscribers to the special fund to finance the Institute which showed an aggregated total of $17,450, and subscriptions pending to the amount of $1,100, making a total of $18,550, of which more than $12,000 had been paid in.

The President reported that he had taken up with the Secretary of the American Society for Testing Materials the question of the classification of the Institute on committees of that Society, and that the Executive Committee of the American Society for Testing Materials decided that the Institute should be classified in accordance with the representative which the Institute appointed on the several Committees of the Society; that is, if the representative were a non-producer, the Institute should be classified as a non-producer; if the representative were a producer, it should be classified as a producer.

The Board decided to take out membership in the American Society for Testing Materials.

The following Committee on Resolutions was appointed:

William K. Hatt, Lafayette, Ind., Chairman.
P. H. Bates, Pittsburgh, Pa.
J. P. Beck, Chicago, Ill.
E. J. Moore, New York, N. Y.
A. L. Johnson, Buffalo, N. Y.

The meeting adjourned at 7 P. M.

ABSTRACT OF MEETING OF BOARD OF DIRECTION, HELD FEBRUARY 10, 1915, AT 1.25 P. M., AT THE AUDITORIUM HOTEL, CHICAGO, ILL.

Present: Richard L. Humphrey, President; Leonard C. Wason, Vice-President; Arthur N. Talbot, William P. Anderson, Henry C. Turner, Directors; Edward E. Krauss, Secretary; C. L. Fish, Assistant Secretary; and Alfred E. Lindau, by invitation.

The President presented a draft of the Annual Report of the Board. This was, after discussion, referred to a committee consisting of Messrs. Wason and Turner, to incorporate the various suggestions made by the Board.

The President, on behalf of the Committee on Medals, presented a report, and the Board adopted the rules governing the awarding of the Leonard C. Wason Medal which authorized the Board to make such changes in these rules as may be found necessary.

The following Committee of Tellers was appointed:

Lewis R. Ferguson, Philadelphia, Pa., Chairman.
L. S. Bruner, Montreal, Canada.
C. K. Arp, Chicago, Ill.

The Board decided that the expenses of the members of the Committee on Edison Fire should be paid and charged against Research, with the understanding that the sale of reprints of this report to the extent of these expenses be credited to this fund.

The President presented a report on the present status of the Trunk Line Association Suit, and stated that the Trunk Line Association was endeavoring to collect from the individual passengers direct. No action was taken in the matter.

It was the sense of the Board that Mr. Richard L. Humphrey be asked to continue his endeavors to secure subscriptions to the fund to finance the Institute, with the understanding that he be reimbursed for his expenses in connection therewith.

The Board authorized the classification of subscribers as contributing members, and elected them to active membership.

The Secretary was instructed to write to each subscriber in hearty appreciation of the contribution made to the fund to finance the Institute, at the same time advising them of their election to active membership of the Institute.

Mr. Boyer reported that he had had a discussion with Mr. Affleck in regard to the Cement Products Exhibition Company giving the Institute a bond to relieve it from any obligations in the Trunk Line Association Suit, and that Mr. Affleck had replied that the letter to the President from Mr. Beck was as good as a bond, and that Mr. Affleck would personally see that the Institute should be indemnified against such obligations. The Secretary was instructed to confirm this by letter to Mr. Affleck.

The meeting adjourned at 2.35 P. M.

ABSTRACT OF MEETING OF THE BOARD OF DIRECTION, HELD FEBRUARY 11, 1915, AT 1 P. M., AT THE AUDITORIUM HOTEL, CHICAGO, ILL.

Present: Richard L. Humphrey, President; Leonard C. Wason, Vice-President; William P. Anderson, William K. Hatt, Robert W. Lesley, Directors; Edward E. Krauss, Secretary; C. L. Fish, Assistant Secretary; and Alfred E. Lindau, by invitation.

The Board decided in view of the necessity of Mr. C. P. Turner leaving the Convention floor during the discussion of his address, that the stenographic report of the discussion should be sent to him for reply to certain questions which had been asked. If he did not present such a reply, it was decided that the stenographic report should be published.

The Board authorized the audit of the accounts of the Institute as of February 13, 1915, and that the books be closed on that date, and all the affairs of the Institute be turned over to the new officers.

The meeting adjourned at 1.05 P. M.

Humphrey, Richard L., Philadelphia, Pa.
Talbot, Arthur N., Urbana, Ill.
Wason, L. C., Boston, Mass.
Anderson, W. P., Cincinnati, Ohio.
Boyer, E. D., New York, N. Y.
Hatt, W. K., Lafayette, Ind.
Leonard, J. B., San Francisco, Cal.
Lesley, R. W., Philadelphia, Pa.
Turner, H. C., New York, N. Y.
Krauss, E. E., Philadelphia, Pa.
Fish, C. L., Philadelphia, Pa.

Arp, C. K., Chicago, Ill.
Affleck, B. F., Chicago, Ill.
Anglin, J. P.,
Ashdowne, E. H.,
Ashton, Ernest, Allentown, Pa.
Abrams, D. A., Chicago, Ill.
Anderson, J. A.,
Anglvine, R. C.,
Abbott, H. C., Chicago, Ill.
Aldrich, Earl, Chicago, Ill.
Atwood, P. H.
Anderson, G. P.
Arnold, J. R., Jr.
Allen, O. T., Chicago, Ill.
Atwood, F. H.
Association, Metal Lath Manufacturers, H. B. McMaster, Youngstown, Ohio.
Bramin, Addison, Aberdeen, Miss.
Balyeat, Luman, Van Wert, Ohio.
Becker, A. B., Chicago, Ill.
Bates, S. E., Chicago, Ill.
Boynton, E. W., Muscatine, Iowa.
Beye, J. C., Oak Park, Ill.
Banfield, Douglas, Chicago, Ill.

Bowditch, John, Jr., Youngstown, Ohio.
Bailey, P. S., Gary, Ind.
Budina, Fred., O'Fallon, Ill.
Buehler, Walter, Hibbing, Minn.
Beck, J. P., Chicago, Ill.
Bowman, R. M., Indianapolis, Ind.
Baumgardner Cement Products Company: C. C. Baumgardner, Tiffin, Ohio.
Baumgardner, A. M., Tiffin, Ohio.
Bates, P. H., Pittsburgh, Pa.
Bengston, C. A., Chicago, Ill.
Battjes, W. J., Grand Rapids, Mich.
Berghoff, L. V., Chicago, Ill.
Bjork, A. E., Chicago, Ill.
Burrows, E. A., Chicago, Ill.
Barron, James, Chicago, Ill.
Bolles, W. B., South Milwaukee, Wis.
Bruner, P. M., St. Louis, Mo.
Brown, H. P., New York, N. Y.
Bachman, H. M., Chicago, Ill.
Bruch, Matthew, Kentland, Ind.
Bone, F. A., Cincinnati, Ohio.
Brainard, C. L., Waterloo, Iowa.
Bissonette, L. A., Chicago, Ill.
Bartlett, G. S., New York, N. Y.
Boynton, C. W., Oakland, Cal.
Byrne, J. H., Cleveland, Ohio.
Bone, E. P., Cincinnati, Ohio.
Bailey, R. W., Anderson, Mich.
Burnett, S. P., Saginaw, Mich.
Blanchard, Murray, Chicago, Ill.
Binswanger, S. J., Chicago, Ill.
Boynton, G. H., Davenport, Iowa.
Cummings, R. A., Pittsburgh, Pa.
Chapman, C. M., New York, N. Y.
Cement Era: E. S. Hanson, Chicago, Ill.
Clarke, R. E., New York, N. Y.
Canada Cement Company, Limited, L. S. Bruner, Montreal, Quebec.

Collings, W. A., Kansas City, Mo.
Coons, E. W., Hibbing, Minn.
Coplay Cement Manufacturing Company: W. G. Dutton, Philadelphia, Pa.
Curtis, A. J., Oak Park, Ill.
Chicago Portland Cement Company: C. M. Wood, Chicago, Ill.
Chicago Portland Cement Company: E. E. Fillion, Chicago, Ill.
Cement World: A. S. Johnson, Chicago, Ill.
Clugston, C. D., Chicago, Ill.
Concrete-Cement Age: H. Whipple, Detroit, Mich.
Cook, W. G., Chicago, Ill.
Concrete Age, The: J. D. Walters, Atlanta, Ga.
Concrete Age, The: A. B. Henry, New York, N. Y.
Cronkrite, A. C., Chicago, Ill.
Condron Company, T. L., Condron, Chicago, Ill.
Chubb, J. H., Minneapolis, Minn.
Carlson, A. G., Chicago, Ill.
Corrugated Bar Company: W. G. Thompson, St. Louis, Mo.
Corrugated Bar Company: F. C. Bagby, St. Louis, Mo.
Carmicheal, W. P., St. Louis, Mo.
Cory, M. M., Chicago, Ill.
Cormolly, P. H., Racine, Wis.
Cary, C. E., Chicago, Ill.
Crain, H. A., Kentland, Ind.
Cobb, G. R., Chicago, Ill.
Corliss, J. L., Chicago, Ill.
Chass, H. B., Jr., Pittsburgh, Pa.
Dixie Portland Cement Company: J. H. Dalbey, Chattanooga, Tenn.
Deffenderfer, C. D., Wilkinsburg, Pa.
Dunning, B. A., Chicago, Ill.
Davis, H. K., Philadelphia, Pa.
Davies, W. M., Wild Rose, Wis.
Dayton, K. P., Chicago, Ill.
DeWolf, F. W., Urbana, Ill.
DeLeuw, O. E., Chicago, Ill.
Ewing, Davis, Bloomington, Ill.
Engineering Record, W. W. DeBerard, Chicago, Ill.
Engineering News: Allen Brett, New York, N. Y.

Eckstrom, L. A., East Chicago, Ind.
Edwards, A. B., Chicago, Ill.
Ferguson, L. R., Philadelphia, Pa.
Freeman, J. E., Chicago, Ill.
Foxmer, H. J., Chicago, Ill.
Furber, P. P., Chicago, Ill.
Fitch, A. L., Chicago, Ill.
Farmer, H. G., Pittsburgh, Pa.
Franks, C. D., Chicago, Ill.
Friedline, Fred, Chicago, Ill.
Friedline, Earl, Chicago, Ill.
Fisher, N. C., Chicago, Ill.
Fox, C. E., Chicago, Ill.
Fowler, E. S., Minneapolis, Minn.
Gelinas, L., Saginaw, Mich.
Goldbeck, A. T., Philadelphia, Pa.
Gonnerman, H. F., Urbana, Ill.
Godfrey, Edward, Pittsburgh, Pa.
Ginsbury, A., Chicago, Ill.
Gregg, K. P., Minneapolis, Minn.
Gregg, T. D., Minneapolis, Minn.
Good Roads: E. W. Powers, Chicago, Ill.
Golden, Philip, Chicago, Ill.
Gilmore, A. J., Kansas City, Mo.
Gulyn, J. W., Lexington, Ky.
Hubbell, C. H., Davenport, Iowa.
Hall, R. F., Chicago, Ill.
Heim, R. F., St. Joseph, Mo.
Hoff, C. P., St. Joseph, Mo.
Herr, C. J., Greenville, Ohio.
Hynds, H. D., New York, N. Y.
Harrington, C. D., Montreal, Quebec.
Hunter, M. R., Chicago, Ill.
Hadsall, H. J., Chicago, Ill.
Heard, F. C., Chicago, Ill.
Harden, W. W., Philadelphia, Pa.
Harmon, L. G., Chicago, Ill.
Haggender, G. A., Chicago, Ill.
Hogan, H. P., Chicago, Ill.

Hendee, Searle, Chicago, Ill.
Havemeyer, J. F., New York, N. Y.
Hussey, M. R., Crookston, Minn.
Hinman, F. G.
Hanby, J. I.
Hauslein, R. G., Chicago, Ill.
Hunt, Leigh, Kansas City, Mo.
Haverkost, E. J., Chicago, Ill.
Hird, G. S., Mitchell, Ind.
Hummel, R. A., La Salle, Ill.
Hardy, Richard, Chattanooga, Tenn.
Hardesty, G. A., Shinneton, W. Va.
Horn, L., Chicago, Ill.
Hammond, A. J., Chicago, Ill.
Harvey, A. P., Chicgao, Ill.
Harridge, J. K., Chicago, Ill.
Hughes, A. E., Chicago, Ill.
Hickman, H. H., Buffalo, N. Y.
Hunt, T. M., Chicago, Ill.
Herron, W. E., Jr., Crawfordsville, Ind.
Heinge, F. F., Ionic, Mich.
Harrison, W. E., Chicago, Ill.
Hunt & Company, R. W., Chicago, Ill.
Hultgren, D. A., Chicago, Ill.
Hauroitch, S. H., Chicago, Ill.
Irvine, F. K., Chicago, Ill.
Isenberg, Gerson, New York, N. Y.
Iben, Reinard, Peoria, Ill.
Ingberg, S. H., Chicago, Ill.
Johnson, A. L., Buffalo, N. Y.
Johnson, N. C., New York, N. Y.
Johnson, J. C., Duluth, Minn.
Jacobus, C. C., Wanwatosa, Wis.
Jeone, G. W., Houston, Texas.
Jones, C. D., Perry, Iowa.
Jones, J. S., Perry, Iowa.
Jaeger, F. L., Chicago, Ill.
Jenks, H. E., Norfolk, Mass.
Kerr, H. D., Chicago, Ill.

Kent, F. J., Shelbyville, Ind.
King, P. W., Chicago, Ill.
Kuelling, H. J., Milwaukee, Wis.
Kapphahn, R. J., Chisholm, Minn.
Keehner, A. F., Jerseyville, Ill.
Kennedy, A. W., Harvey, Ill.
Karp, E. A., Chicago, Ill.
Kelly, F. W., Albany, N. Y.
Kennicott, L. A., Chicago, Ill.
Kennedy, J. R., Parkersburg, W. Va.
Keyes, B. S., Chicago, Ill.
Krippner, John, Chicago, Ill.
Kattelle, W. R., Chicago, Ill.
Kremer, W. H., Chicago, Ill.
Kupper, H. F., Peoria, Ill.
Kinney, W. M., Chicago, Ill.
Lohman, F. C., Champaign, Ill.
Leavitt, H. P., Chicago, Ill.
Lang, F. C., Chisholm, Minn.
Libberton, J. H., Chicago, Ill.
Lowell, J. W., Chicago, Ill.
Light, C. P., Washington, D. C.
Lytle, J. H., Dayton, Ohio.
Lowenberg, M. L., Chicago, Ill.
Laub, Hermann, Jr., Chicago, Ill.
Lommer, E. A.
Lindau, A. E., Chicago, Ill.
Lillie, G. F., Fremont, Neb.
Lurie, E. M., Chicago, Ill.
Lloyd, Walter, Poughkeepsie, N. Y.
Maynard, A. J., State Farm, Mass.
McCullough, E. B., Chicago, Ill.
Miller, O. A., Richmond, Ind.
Mueller, J. W., Newcastle, Ind.
Macgowan, E. S.
McCarthy, Joseph.
McCormick, E. B., Washington, D. C.
Mensch, L. J., Chicago, Ill.
Mingle, J. G.

Moritz, G.
Marsch, D. E.
McGee, H. L., New York, N. Y.
Moore, E. J., New York, N. Y.
Malcolm, C. W., Chicago, Ill.
Morgan, H. H., Chicago, Ill.
Michel, E. H.
Mann, J. T.
Moyer, Albert, New York, N. Y.
Myers, C. C.
Marshall, R., Detroit, Mich.
McDonald, B. S., Chicago, Ill.
Nares, B. L., Chicago, Ill.
Newaygo Cement Company: J. E. John, Grand Rapids, Mich.
Nicely, Harry, Parkersburg, W. Va.
Ogden, W. H.
Parker, E. E.
Pease, B. S., Chicago, Ill.
Packman, L. S.
Pittsburgh Testing Laboratory, Pittsburgh, Pa.
Powell, C. M., Chicago, Ill.
Perrot, E. G., Philadelphia, Pa.
Powell, C. O.
Pennartz, R. H., Fort Madison, Iowa.
Pabst, F. S., Chicago, Ill.
Patten, A. J., Lansing, Mich.
Perkins, C. A., Chicago, Ill.
Post, C. L., Chicago, Ill.
Phelphs, F. W., Lexington, Ky.
Pestor, A. H., Chicago, Ill.
Rader, B. A., Pittsburgh, Pa.
Reiter, S. H., Chicago, Ill.
Rock Products: C. A. Olsen, Chicago, Ill.
Rock Products: F. G. Pulley, Chicago, Ill.
Russell, C. E., Lake Forest, Ill.
Reeves, W. F.
Rappaport, B. J., Chicago, Ill.
Robinson, Philip, Chicago, Ill.
Rayburn, W. D. K., Chicago, Ill.

Rice, L. V., Chicago, Ill.
Rhode, Howard, Philadelphia, Pa.
Reed, A. Y., Elgin, Ill.
Richardson, H. H., Chicago, Ill.
Randolph, S. M., Chicago, Ill.
Sommer, E. A., Chicago, Ill.
Shainwold, R. L., Jr., New York, N. Y.
Sayle, G. C., Madison, Wis.
Stivers, C. P., Chicago, Ill.
Smith, F. C., Sioux City, Iowa.
Steele, G. D., Philadelphia, Pa.
Stephens, J. M., Shelbyville, Ind.
Sizer, L. N., Champaign, Ill.
Story, O. J., Chicago, Ill.
Smith, W. F., Chicago, Ill.
Smith, B. S., Chicago, Ill.
Slater, W. A., Urbana, Ill.
Schilling, Adolf, Haddon Heights, N. J.
Schaefer, J. V., Chicago, Ill.
Southwestern Portland Cement Company: C. Leonhardt, El Paso, Texas.
Snell, H. W., Chicago, Ill.
Strand, W. C., Chicago, Ill.
Stone, L. L., Kansas City, Mo.
Scovel, G. D., Chicago, Ill.
Stolberg, E. C., Chicago, Ill.
Spreiter, W. E., Onaloska, Wis.
Symonds, H. D., Chicago, Ill.
Stone, F. N., Chicago, Ill.
Sargent, W. F., Oak Park, Ill.
Smith, W. T., Chicago, Ill.
Thompson, S. E., Newton Highlands, Mass.
Thomas, C. R., Chicago, Ill.
Tubesing, W. F., Milwaukee, Wis.
Tower, C. D., Wheeling, W. Va.
Taylor, H. A., Jackson, Ill.
Talbot, K. H., Pittsburgh, Pa.
Turner, C. A. P., Minneapolis, Minn.
Taylor, R. G., Chicago, Ill.

Towne, L. J., Urbana, Ill.
Tompkins, H. D., Jersey City, N. J.
Tratman, E. E. R., Chicago, Ill.
Thomas, Ira A., Warren, Ohio.
Ubbink, Joe, Port Washington, Wis.
Van Doorn, J. C., Minneapolis, Minn.
Van Vliet, P. D., Chicago, Ill.
von Mueller, Curt, Chicago, Ill.
Whited, W. Harrisburg, Pa.
Wight, F. C., New York, N. Y.
Wig, R. J., Washington, D. C.
Wilson, P. H., Philadelphia, Pa.
Wright, A. W., Newcastle, Ind.
Willis, Thomas, New Orleans, La.
Whitney, H. K., Battle Creek, Mich.
Wilson, E. B., Chicago, Ill.
Watson, E. W., Chicago, Ill.
Wallace, R. W., Chicago, Ill.
Woodworth, C. P., Chicago, Ill.
Westergaard, H. M., Champaign, Ill.
Wilk, Benjamin, Virginia, Minn.
Watson, C. D., Wycombe, Pa.
West, A. J., Chicago, Ill.
Wilby, A. C., Chicago, Ill.
Williamson, Russell, Chicago, Ill.
Witmer, H. S., Chicago, Ill.
Washburne, R. H., Milwaukee, Wis.
Waterbury, L. A., Tucson, Ariz.
Winterhalter, L. P., Akron, Ohio.
Weber, Carl, Chicago, Ill.
Young, C. A., Chicago, Ill.
York, J. D., Chicago, Ill.
Young, R. W., Paullina, Iowa.
Zeidler, J. L., St. Joseph, Mo.

PROPOSED STANDARD SPECIFICATIONS FOR ONE-COURSE CONCRETE ALLEY PAVEMENT.

I. Materials.

1. *Cement.*—The cement shall meet the requirements of the Standard Specifications for Portland Cement, adopted by the American Society for Testing Materials, August 16, 1909, with all subsequent amendments and additions thereto adopted by said Society and by this Institute. (Standard No. 1.) **Cement.**

2. *Aggregates.*—Before delivery on the job, the contractor shall submit to the engineer a fifty (50) lb. sample of each of the fine and coarse aggregates proposed for use. These samples shall be tested and if found to pass the requirements of the specifications similar material shall be considered as acceptable for the work. All aggregates used shall meet with the approval of the engineer and shall fulfill the requirements of these specifications. In no case shall aggregates containing frost or lumps of frozen materials be used. **Aggregates.**

Fine Aggregate.—Fine aggregate shall consist of natural sand or screenings from hard, tough, durable crushed rock or gravel, consisting of quartzite grains or other equally hard material graded from fine to coarse, with the coarse particles predominating. Fine aggregate, when dry, shall pass a screen having four (4) meshes per linear inch; not more than twenty-five (25) per cent shall pass a sieve having fifty (50) meshes per linear inch, and not more than five (5) per cent shall pass a sieve having one hundred (100) meshes per linear inch. Fine aggregate shall not contain vegetable or other deleterious matter nor more than three (3) per cent of clay or loam. **Fine Aggregate.**

Fine aggregate shall be of such quality that mortar composed of one (1) part Portland cement and three (3) parts fine aggregate, by weight, when made into briquettes, shall show a tensile strength (at seven (7) and twenty-eight (28) days) at least equal to the strength of briquettes composed of one (1) part of the same cement and three (3) parts Standard Ottawa sand by weight. The percentage of water used in making the briquettes of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa sand briquettes of Standard consistency. In other respects all briquettes shall be made in accordance with the Report of Committee on Uniform Tests of Cement of the American Society of Civil Engineers.

Coarse Aggregate.

Coarse Aggregate.—Coarse aggregate shall consist of clean, hard, tough, durable crushed rock or gravel graded in size, free from vegetable or other deleterious matter, and shall contain no soft, flat or elongated particles. The size of the coarse aggregate shall be such as to pass a one and one-half ($1\frac{1}{2}$) in. round opening and shall range from one and one-half ($1\frac{1}{2}$) in. down, not more than five (5) per cent passing a screen having four (4) meshes per linear inch, and no intermediate sizes shall be removed.

Mixed Aggregate.

3. *Mixed Aggregate.*—Crusher-run stone, bank-run gravel or artificially prepared mixtures of fine and coarse aggregate shall not be used.

Water.

4. *Water.*—Water shall be clean, free from oil, acid, alkali or vegetable matter.

Reinforcement.

5. *Reinforcement.*—All reinforcement shall be free from excessive rust, scale, paint or coatings of any character which will tend to destroy the bond. All reinforcement shall develop an ultimate tensile strength of not less than seventy thousand (70,000) lb. per sq. in. and bend one hundred and eighty (180) degrees around one diameter and straighten without fracture.

Joint Filler.

6. *Joint Filler.*—The filler for all transverse joints shall consist of prepared strips of fibre matrix and bitumen or similar material of approved quality one-quarter ($\frac{1}{4}$) in. in thickness. Where the joints are protected with metal plates the joint filler shall be made to conform to the cross-section of the pavement and where unprotected transverse joints are used the width of the joint filler shall be at least one-half ($\frac{1}{2}$) in. greater than the thickness of the pavement at any point. The filler for longi-

tudinal joints shall, at the discretion of the engineer, consist of the same material as specified for the transverse joints or of bitumen which will not become soft enough to flow in hot weather or brittle in cold weather. The thickness of longitudinal joints filled with bitumen shall not be less than one-quarter ($\frac{1}{4}$) in. or more than three-quarter ($\frac{3}{4}$) in.

Joint Protection Plates.

7. *Joint Protection Plates.*—Soft steel plates for the protection of the edges of the concrete at transverse joints shall be not less than two and one-half ($2\frac{1}{2}$) in. in depth and not less than one-eighth ($\frac{1}{8}$) in. nor more than one-quarter ($\frac{1}{4}$) in. average thickness. The plates shall be of such form as to provide for rigid anchorage to the concrete. The type and method of installation of joint protection plates shall be approved by the engineer.

II. GRADING.

8. *Defined.*—Grading shall include all cuts, fills, approaches and all earth or rock moving for whatever purpose where such work is an essential part of or necessary to the prosecution of the contract.

Engineer's Stakes.

9. *Engineer's Stakes.*—Stakes will be set by the engineer for the center line, finished grades and other necessary points.

Excess Material.

10. *Excess Material.*—Excess material shall be disposed of as directed by the engineer, the free haul not to exceed ..... ft.

11. *Over-Haul.*—Materials hauled a greater distance than the free haul from the place of excavation shall be paid for at the rate of ..... cents per cu. yd. for each additional ..... ft.

Cuts and Fills.

12. *Cuts and Fills.*—In cuts the final grade shall be obtained by rolling with a roller weighing not less than five (5) nor more than ten (10) tons. The engineer shall determine the depth of material to be thus compacted. When a fill of one (1) ft. or less is required to bring the surface to grade, all vegetable or other perishable matter shall be removed before making the fill.

Embankments shall be formed of earth or other approved materials and shall be constructed in successive layers, each of which shall extend entirely across the width to be filled. Each layer, which shall not exceed one (1) ft. in depth, shall be thoroughly rolled with a roller weighing not less than five (5) nor more than ten (10) tons before the succeeding layer is placed. The roller shall pass over the entire area of each layer of the fill at least

twice. The use of muck, quicksand, soft clay, spongy or perishable material which will not consolidate under the roller, is prohibited.

When the material excavated from the cuts is not sufficient to make the fills shown on the plans, the contractor shall furnish the necessary extra material to bring the fills to the proper width and grade. When the earth work is completed the cross-section of the roadbed shall conform to the cross-sectional drawings and profile attached hereto.

All approaches connecting the specified pavement with other streets or alleys intersecting shall also be cut or filled, and secured from settlement, to form a slope of not more than one (1) vertical to ten (10) horizontal, as shown on the profile and plans attached hereto.

III. DRAINAGE.

Drainage. 13. *Drainage.*—The contractor shall construct tile or other drains as shown in the drawings attached hereto. Tile to be laid in the trench at least ..... (.....) in. wide, and ..... (.....) ft. deep below the established grade of the pavement. Such trench shall be back filled with crushed stone or pit run gravel with sand removed, which after light tamping shall be ..... (.....) in. in depth.

Catch Basins. 14. *Catch Basins.*—All catch basins and manhole tops and all covers of openings of any kind shall be readjusted to the grade by the contractor at his expense.

IV. SUB-GRADE.

Sub-Grade. 15. *Construction.*—The bottom of the excavation or the top of the fill when completed shall be known as the sub-grade and shall be at all places true to the elevation as shown on the plans attached hereto.

The sub-grade shall be brought to a firm, unyielding surface by rolling the entire area with a self-propelled roller weighing not less than five (5) nor more than ten (10) tons, and all portions of the surface of the sub-grade which are inaccessible to the roller shall be thoroughly tamped with a hand tamp weighing not less than fifty (50) lb., the face of which shall not exceed one hundred (100) sq. in. in area. All soft, spongy or yielding spots and all vegetable

or other perishable matter shall be entirely removed and the space refilled with suitable material.

When considered necessary or of assistance in producing a compact, solid surface, the sub-grade before being rolled shall be well sprinkled with water.

When the concrete pavement is to be constructed over an old pavement composed of gravel or macadam, the latter shall be entirely loosened and the material spread for the full width of the pavement and rolled. All interstices shall be filled with fine material and rolled to make a dense, tight surface.

16. *Acceptance.*—No concrete shall be deposited until the sub-grade is checked and accepted by the engineer.

V. FORMS.

Forms.

17. *Materials.*—Metal or wooden forms shall be free from warp, of sufficient strength to resist springing out of shape, and shall be equal in width to the thickness of the pavement at the edges. Wooden forms shall be of not less than two (2)-in. stock. Where the pavement is laid adjacent to buildings, fences or other structures, the side forms may be omitted at the direction of the engineer, but a joint must be constructed as hereinafter specified between the pavement and such structure.

18. *Setting.*—The forms shall be well staked or otherwise held to the established line and grades and the upper edge shall conform to the established grade of the alley.

19. *Treatment.*—All mortar and dirt shall be removed from the forms that have previously been used.

VI. PAVEMENT SECTION.

Pavement Section.

20. *Width, Thickness of Pavement and Cross-Section.*—The width of the pavement shall be ..... (.....) ft., ... (.....) in. and not less than six (6) in. uniform thickness. In cross-section the finished surface shall have the uniform pitch toward the center line, except the center twelve (12) in. shall be rounded to the arc of a circle which is tangent to the surface of the concrete at points six (6) in. on each side of the center line, as shown in the plans attached hereto. The pitch shall not exceed one-fiftieth ($\frac{1}{50}$) of the width of the pavement.

VII. JOINTS.

Joints.

21. *Width and Location.*—Transverse joints shall be one-quarter ($\frac{1}{4}$) in. in width and shall be placed across the pavement perpendicular to the center line, not more than thirty-six (36) ft. apart. When the pavement is laid adjacent to buildings, fences, or other structures, a longitudinal joint shall, at the discretion of the engineer, be constructed. All joints shall extend through the entire thickness of the pavement and shall be perpendicular to its surface.

22. *Joint Filler.*—All transverse joints shall be formed by inserting during construction and leaving in place the required thickness of prepared strips of fibre matrix and bitumen or other similar material of approved quality, which shall extend through the entire thickness of the pavement.

Longitudinal joints shall, at the discretion of the engineer, be formed in the same manner as transverse joints or constructed by filling with bitumen as before specified.

23. *Protected Joints.**—The concrete at all transverse joints shall be protected with joint protection plates which shall be rigidly anchored to the concrete. The upper edges of the plates shall be even with each other and the adjoining surface of the concrete. All steel plates varying more than one-quarter ($\frac{1}{4}$) in. from the finished surface of the concrete, as shown on the plans attached hereto, shall be ground to meet the specified requirements, or slabs in which such plates occur shall be removed and replaced with new material by the contractor at his expense.

24. *Unprotected Joints.**—All transverse joints shall extend through the entire thickness of the pavement and the filler shall project not less than one-half ($\frac{1}{2}$) in. above the finished surface. The concrete adjacent to these joints shall be finished with a wood float, which is divided through the center and which will permit finishing on both sides of the filler at the same time. Before the pavement is opened to traffic, joint filler shall be cut off to the height of one-quarter ($\frac{1}{4}$) in. above the surface of the pavement.

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* When the specification "Protected Joints" is to be used, "Unprotected Joints" shall be omitted, and *vice versa*.

VIII. MEASURING MATERIALS AND MIXING CONCRETE.

25. *Measuring Materials.*—The method of measuring the materials for the concrete, including water, shall be one which will insure separate and uniform proportions of each of the materials at all times. A bag of Portland cement (94 lb. net) shall be considered one (1) cu. ft. **Measuring Materials.**

26. *Mixing.*—The materials shall be mixed in a batch mixer of approved type and mixing shall continue after all materials are in the drum for at least one (1) minute at a minimum speed of twelve (12) revolutions per minute. The drum shall be completely emptied before receiving materials for successive batches. **Mixing.**

27. *Re-tempering.*—Re-tempering of mortar or concrete which has partially hardened, that is, remixing with or without additional materials or water, shall not be permitted. **Re-tempering.**

28. *Proportions.*—The concrete shall be mixed in the proportions of one (1) bag of Portland cement to not more than two (2) cu. ft. of fine aggregate and not more than three (3) cu. ft. of coarse aggregate, and in no case shall the volume of the fine aggregate be less than one-half ($\frac{1}{2}$) the volume of the coarse aggregate. **Proportions.**

A cubic yard of concrete in place shall contain not less than one and seven-tenths (1.7) barrels of cement.

The engineer shall compare the calculated amount of cement required according to these specifications and plans attached hereto with the amounts actually used in each section of concrete between successive transverse joints, as determined by actual count of the number of bags of cement used in each section. If the amount of cement used in any three (3) adjacent sections (between transverse joints) is less by more than two (2) per cent, or if the amount of cement used in one section is less by more than five (5) per cent of the amount hereinbefore required, the contractor shall remove all such sections and replace the same with new materials, according to these specifications, at his expense.

29. *Consistency.*—The materials shall be mixed with sufficient water to produce a concrete which will hold its shape when struck off with a template. The consistency shall not be such as to cause a separation of the mortar from the coarse aggregate in handling. **Consistency.**

IX. REINFORCING.

Reinforcing.

30. *Reinforcing.*—Concrete pavements twenty (20) ft. or more in width, shall be reinforced. The cross-sectional area of the reinforcing metal running parallel to the center line of the pavement shall amount to at least 0.038 sq. in. per ft., and the cross-sectional area of reinforcing metal which is perpendicular to the center line of the pavement shall amount to at least 0.049 sq. in. per ft.

Reinforcing metal shall not be placed less than two (2) in. from the finished surface of the pavement and otherwise shall be placed as shown on the drawings attached hereto. The reinforcing metal shall extend to within two (2) in. of all joints, but shall not cross them. Adjacent widths of fabric shall be lapped not less than four (4) in. when the lap is made perpendicular to the center line of the pavement, and not less than one (1) ft. when the lap is made parallel to the center line of the pavement.

X. PLACING CONCRETE.

Placing Concrete.

31. *Placing Concrete.*—Immediately prior to placing the concrete, the sub-grade shall be brought to an even surface. The surface of the sub-grade shall be thoroughly wet, but shall show no pools of water when the concrete is placed.

After mixing, the concrete shall be deposited rapidly upon the sub-grade to the required depth and for the entire width of the pavement in successive batches and in a continuous operation without the use of intermediate forms or bulkheads between expansion joints.

In case of a breakdown, concrete shall be mixed by hand to complete the section or an intermediate transverse joint placed as hereinbefore specified at the point of stopping work. Any concrete in excess of that needed to complete a section at the stopping of work shall not be used in the work.

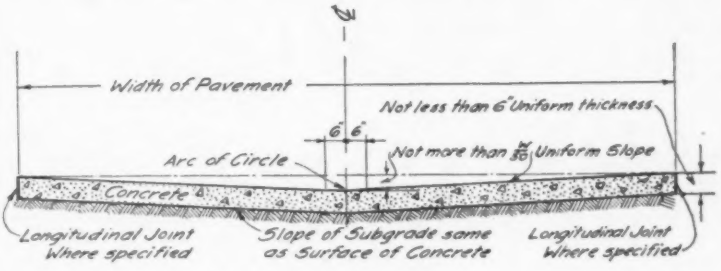
32. *Finishing.*—The surface of the concrete shall be struck off by means of a template or strikeboard. Any holes left by removing any material or device used in constructing the joint shall be immediately filled with mortar composed of one (1) part cement and two (2) parts of fine aggregate. Concrete adjoining metal protection plates at transverse joints shall be dense in character and shall be given a smooth finish with a steel trowel for a distance of six (6) in. on each side of the joints.

After being brought to the established grade with the template or strikeboard, the concrete shall, where possible, be finished from a suitable bridge, no part of which shall come in contact with the concrete. The concrete shall be finished with a wood float in a manner to thoroughly compact it and produce a surface free from depressions or inequalities of any kind. The finished surface of the pavement shall not vary more than one-quarter ($\frac{1}{4}$) in. from the true shape.

XI. PROTECTION.

33. *Curing and Protection.*—Excepting as hereinafter specified, the surface of the pavement shall be sprayed with water as soon as the concrete is sufficiently hardened to prevent pitting, and shall

Protection.



Note:- "W" denotes width of pavement

be kept wet until an earth or other approved covering is placed. As soon as it can be done without damaging the concrete, the surface of the pavement shall be covered with not less than two (2) in. of earth or other material approved by the engineer, which cover shall be kept wet for at least ten (10) days. When deemed necessary or advisable by the engineer, freshly laid concrete shall be protected by canvas until such covering can be placed.

Under the most favorable conditions for hardening in hot weather, the pavement shall be closed to traffic for at least fourteen (14) days and in cool weather for an additional time, to be determined by the engineer.

At the season of the year when the average temperature is below 50 degrees Fahrenheit, sprinkling and covering of the pavement may be omitted at the direction of the engineer.

The contractor shall erect and maintain suitable barriers to protect the concrete from traffic and any part of the pavement damaged from traffic or other causes, occurring prior to its official acceptance, shall be repaired or replaced by the contractor at his expense, in a manner satisfactory to the engineer. Before the pavement is thrown open to traffic the covering shall be removed and disposed of as directed by the engineer.

Freezing.

34. *Temperature Below 35 Degrees Fahrenheit.*—Concrete shall not be mixed or deposited when the temperature is below freezing.

If at any time during the progress of the work the temperature is or, in the opinion of the engineer will, within twenty-four (24) hours drop to thirty-five (35) degrees Fahrenheit, the water and aggregates shall be heated and precautions taken to protect the work from freezing for at least ten (10) days. In no case shall concrete be deposited upon a frozen sub-grade.

Synopses of Recent Articles on Concrete.

Reviewed February 1 to 28, 1915.

The synopses given below are for the purpose of keeping the members of the Institute in touch with the leading articles of interest appearing in the many technical journals and are not complete reviews of these journals. The publications regularly reviewed appear below and the number given corresponds to the number following the title of the paper. The length of the article in pages, whether illustrated or not, is noted, and the publications reviewed in which it appears:

1. Canadian Engineer, Toronto, Ontario, Canada.
2. Cement, New York, N. Y.
3. Cement Era, Chicago, Ill.
4. Cement World, Chicago, Ill.
5. Concrete Age, Atlanta, Ga.
6. Concrete Era, Los Angeles, Cal.
7. Concrete-Cement Age, Detroit, Mich.
8. Concrete and Constructional Engineering, London, England.
9. Engineering and Contracting, Chicago, Ill.
10. Engineering News, New York, N. Y.
11. Engineering Record, New York, N. Y.
12. Good Roads Magazine, New York, N. Y.
13. Portland Cement, Kansas City, Mo.
14. Rock Products, Chicago, Ill.
15. Proceedings American Railway Engineering Association, Chicago, Ill.
16. Western Contractor, Record Building, Kansas City, Mo.
17. Journal National Fire Protection Association, Boston, Mass.
18. Journal Western Society of Engineers, Chicago, Ill.
19. Proceedings American Society of Civil Engineers, New York, N. Y.
20. Proceedings American Society of Municipal Improvements, New York.
21. Proceedings American Society for Testing Materials, Philadelphia, Pa.
22. Proceedings Engineers' Club of Philadelphia, Philadelphia, Pa.
23. Proceedings Engineers' Society of Western Pennsylvania, Pittsburgh, Pa.
24. Professional Memoirs, Corps of Engrs., U. S. A., Washington, D. C.
25. Proceedings Institution of Civil Engineers, London, England.
26. Transactions, Canadian Society of Civil Engineers, Montreal, Quebec, Canada.
27. Railway Age Gazette, Chicago, Ill.
28. Better Roads, Jamestown, Ohio.

MATERIALS

Importance of Proper Aggregates in Concrete Construction, by MacRae D. Campbell. (27) Feb. 19, 1½ pp., ill.

DESIGN AND TESTS

Standard Practice Instructions for Concrete Testing Laboratory, by Ralph E. Goodwin. (10) Feb. 4, 6¼ pp., ill. Details of practice of concrete-testing laboratory of the Public Service Commission of New York City.

Some Field and Laboratory Tests of Concrete, by H. S. Mattimore. (10) Feb. 4, 1 p., ill. Data from the work of New York State Highway Commission, including important checks on finished product.

Specifications for Concrete Aggregates and Results of Field Tests, by Ralph E. Goodwin. (10) Feb. 11, 3 pp., ill. Continuation of paper by same author in issue of Feb. 4th.

Tests and Uses of Hydrated Lime, by R. C. Haff. (3) 1 p., ill.

Mechanical Disintegration of Defective Concretes, by Nathan C. Johnson. (11) Feb. 6, 4 pp., ill. Second article in series of six—Demonstrating certain disruptive crystalline actions, which have their inception in the capillary pores.

Economic Design of Concrete Slabs, by J. Norman Jensen. (11) Feb. 6, 2 pp., ill. Analysis of stresses and costs of reinforced concrete floor panel construction, based on cheapest possible design.

Microscope as an Aid in Proportioning Concrete for Strength, by Nathan C. Johnson. (11) Feb. 13, 3 pp., ill. Third in a series of six articles—Demonstrating the influence on strength of the ratio of cement to aggregate "Burden."

Microscope as a Check on Construction, by Nathan C. Johnson. (11) Feb. 27, 2¾ pp., ill. Fourth in a series of six articles—Demonstrating the quantitative mechanical analysis of new and old concretes.

Problems in the Theory of Construction, Column Bending Moments in Frame Construction, by Ewart S. Andrews. (8) Feb., 8½ pp., ill. A mathematical discussion.

What is 1: 2: 4 Concrete? by H. C. Johnson. (8) Feb., 7½ pp. A discussion of the proportioning of aggregates.

Notes on the Tests of Some Large Reinforced Concrete Culvert Pipe, by W. J. Schlick. (7) Feb., 2½ pp., ill.

BUILDINGS

Repairing a Badly Corroded Iron Chimney during Operation. (10) Feb. 4, ½ p., ill. Description of method showing iron chimney strengthened by reinforced concrete jacket.

A Concrete Floor Hardening System. (10) Feb. 4, ½ p. Description of system used extensively to give a hard and dustless surface.

End Framing for Armory at University of Illinois and Some General Features of this Structure. (9) Feb. 17, 2½ pp., ill. Article on various uses of cement in this structure, including cement-gun cornice finish.

A Model Factory Building for Small Plants in Toledo, Ohio. (9) Feb. 17, 1½ pp., ill. A four-story reinforced concrete structure built in two main sections or units, each 200 x 90 ft. in plan and connected by an intermediate section 66 x 66 ft.

Concrete Where "Movies" are Made, by Albert Marple. (3) 2 pp., ill.

Reinforced-Concrete Roundhouse at Du Bois. (11) Feb. 6, 2½ pp., ill. Structural and mechanical features of sixteen-stall house recently completed by Buffalo, Rochester & Pittsburgh Rwy.

A Reinforced Concrete Building for the Ford Motor Co., Chicago. (8) Feb., 8 pp., ill. Design and description of building 232 ft. x 164 ft., six stories high.

Methods and Costs in Constructing Factory Building at Houston, Texas, by Lee A. Hoynck. (7) Feb., 5 pp., ill. Building 218 x 80 ft., 3 stories and basement.

Methods and Costs of Providing Slopes for Drainage on Flat Concrete Roofs, by Albert M. Wolf. (7) Feb., 2½ pp., ill.

HOMES

Latest North Shore Concrete Homes, Charles E. White, Jr. (3) Feb., 3 pp., ill. Design and description of house built of concrete blocks and covered with cement plaster.

BRIDGES AND RAILROAD WORK

The City Tunnel of the Catskill Aqueduct, by Walter E. Spear. (10) Feb. 4, 5½ pp., ill. A description of the concreting.

Some Experiences with Concrete in the Republic of Panama, by Alex. P. Crary. (10) Feb. 4, 2½ pp., ill. Data on effect of sea water on concrete, reinforced concrete roof construction and description of wharf constructed at Panama.

Methods Used on an Illinois Bridge. (3) Feb., 1½ pp., ill. Use of old iron bridge to carry and place concrete for new structure.

Half-Mile Concrete Viaduct Provides Double-Deck Trafficway in Kansas City, by H. H. Fox. (11) Feb. 6, 2½ pp., ill. Monumental structure, costing about $625,000, forms important travel link between city center and railway terminus district.

Five Bridges Erected in Two Days. (11) Feb. 6, 2¼ pp., ill. Unit system of reinforced concrete solves time element on overhead farm crossings rebuilt by Delaware, Lackawanna and Western R. R. Co.

Design Features of the Various Types of Reinforced Concrete Bridges along the Columbia Highway, in Oregon, by K. P. Billner. (9) Feb. 10, 2⅔ pp., ill.

Estimating Curves for Standard Bridges of the Illinois Highway Department. (9) Feb. 10, 3 pp., ill.

Design, Construction and Detailed Costs of the McKinley Ford Bridge, La Salle Co., Illinois. (9) Feb. 24, 3 pp., ill. Bridge consists of two 50-ft. reinforced concrete through girder spans on a concrete pier and abutments.

Progress of Summit Cut-Off of the Lackawanna. (27) Feb. 5, 5 pp., ill. A description of the present stage of construction of World's Largest Concrete Bridge and a 3,630-ft. tunnel.

Methods and Costs of Constructing the Bay St. Underpass at Macon, Ga., by Carl H. Fuller. (7) Feb., 3½ pp., ill.

RESERVOIRS, DAMS, CANALS, ETC.

Progress on the Greater Winnipeg Aqueduct. (10) Feb. 4, 2 pp., ill.

The Valier-Montana Irrigation Project, by Kenneth A. Heron. (10) Feb. 11, 6 pp., ill. Description of work giving details, views and plans of headgates, pipe-line drops and chutes of concrete construction.

Plant Arrangement and Form Construction for Coon Rapids Dam, Minnesota. (9) Feb. 17, 1½ pp., ill.

Pittsburgh North Side Reservoir. (3) Feb., 3 pp., ill. Description. The retaining walls, conduits, dividing walls, drains, slope and floor paving and gate house foundations were all of concrete.

Highway Retaining Wall and Spillway. (3) Feb., 2 pp., ill. Design and description of road with large ditches on each side which were forced to capacity to carry off surface water.

Progress on Arrowrock Dam, by Charles H. Paul. (10) Feb. 25, 1¼ pp., ill. 359,240 cu. yd. of concrete placed during 1914.

Design Low Dam for 30-foot Height Increase. (11) Feb. 6, 1¼ pp., ill.

Yardage Record at Kensico Dam Due, in Part, to Operation of Mixers, by George T. Seabury. (11) Feb. 13, 1 p. By placing 489,000 yards of cyclopean masonry in 1914 and 1913 performance was exceeded by 173,000 yds.

San Francisco's Notable Engineering Works. (11) Feb. 20, 6 pp., ill. A summary of the more interesting projects near the city with special attention to construction now under way—A useful guide for engineers who attend the exposition.

Suspended Fenders a Feature of New Reinforced Concrete Piers at San Francisco, by Frank G. White. (11) Feb. 20, 2½ pp., ill. New system with fenders out of reach of borers, expected greatly to reduce maintenance—piers typify arrangement to suit tenants.

New City Reservoir, Regina, Sask., by R. O. Wynne-Roberts. (1) Feb. 25, 6½ pp., ill. Notes on water supply and proposed scheme of additions of which this 5,000,000-gallon reservoir is a part. Notes on its design and construction.

Methods and Costs of Constructing Concrete Lining for Twenty Irrigation Canals. (9) Feb. 10, 6 pp., ill.

Design Features of Cottonwood Conduit and New Concrete Settling Basin at San Diego, Cal. Feb. 10, 2 pp., ill.

Reinforced Concrete Caissons at Sunderland Docks. (8) Feb., 3½ pp., ill. Description of caissons built in the dry and floated into position.

Brushed Concrete Balustrade Along Erie Canal, Rochester, N. Y. (7) Feb., 1½ pp., ill.

ROADS AND PAVEMENTS

Some Features of Brick Road Construction in Illinois. (9) Feb. 17, 1½ pp., ill. Contains a description of concrete base, method of curb construction and mixing and placing grout filler.

Concrete Paving without Cracks, by A. H. Kindrick. (3) Feb., 2 pp., ill.

Integral Curb for Concrete Pavement, by C. M. Powell. (3) Feb., 1½ pp., ill. Showing types of curbs and gutters built integral with concrete roads and pavements.

Methods and Cost of Constructing Nine Miles of Concrete State Road in California. (9) Feb. 3, 2 pp., ill.

Methods and Cost of Constructing a Concrete Road in La Salle Co., Illinois. (9) Feb. 3, 1 p., ill.

Practical Kinks in Concrete Road and Pavement Construction. (9) Feb. 10, 4 pp., ill. Paper by C. D. Franks.

Methods and Cost of Concrete Road Construction by Day Labor Under the Supervision of the Illinois Highway Commission. (9) 2½ pp., ill. Paper by A. H. Hunter.

Construction of Concrete Roads in Milwaukee County, Wis., in 1914, by H. J. Kuelling. (7) Feb., 3 pp., ill.

SEWERS, PIPE TILE, ETC.

Making Concrete Pipe Nine Feet in Diameter, by Charles Harrison. (3) 1¾ pp., ill.

Covering Protects Large Penstocks from Freezing, by H. G. Huber. (11) Feb. 27, 1 p., ill. Cement-mortar coating is supported by special steel frame around pipe and reinforced with wire mesh.

Proposed Method of Enclosing a Stream in Reinforced Concrete Conduit through Mansfield, Ohio. (9) Feb. 10, 2 pp., ill.

Design and Construction Features of Reinforced Concrete Sewer Syphons under New York Subways. (9) Feb. 10, 2 pp.

Layout, Operation and Selling Methods of a Structural Tile Manufactory, by Harvey Whipple. (7) Feb., 6 pp., ill.

MISCELLANEOUS

Pouring Concrete by Compressed Air. (1) Feb. 4, 5 pp., ill. Description of mixing and placing concrete by this method.

A Concrete Chuting Plant with Braced Boom and Chute, by Everett L. Jones. (**10**) Feb. 4, 1½ pp., ill. Description of plant with effective layout and some special construction details; maximum daily output 300 cu. yd.

How I Built My Concrete Garage, by T. T. Watson. (**3**) Feb., 2 pp., ill.

An Instance of Lightning on a Steel Dome and Reinforced Concrete Walls. (**8**) Feb., 2 pp. Particulars regarding the effect of lightning on reinforced concrete.

The Application of Concrete in Modern Sanitation, by Henry J. Tingle. (**8**) Feb., 7½ pp., ill. A paper and discussion.

Field Methods in Concrete Construction—Proportioning and Mixing Concrete, by Jerome Cochran. (**7**) Feb., 2½ pp.

Design Methods in Concrete Construction—Graphical Statics of Simple Beams, by Jerome Cochran. (**7**) Feb., 2½ pp., ill.

The Concrete Fence Post Factory of the C. B. & Q. R. R. Co., Havelock, Nebr., by W. W. Eldridge. (**7**) Feb., 2¼ pp., ill.

PART II.

PROCEEDINGS ELEVENTH ANNUAL CONVENTION.

Papers, Discussions and Reports.

American Concrete Institute

PROCEEDINGS

OF THE

ELEVENTH CONVENTION

This Institute is not responsible, as a body, for the statements and opinions advanced in its publications.

SUMMARY OF THE PROCEEDINGS OF THE ELEVENTH ANNUAL CONVENTION.

First Session, Tuesday, February 9, 1915, 10 a. m.

The Convention was called to order by the President, Richard L. Humphrey.

The Honorable Lawrence E. McGann, Commissioner of Public Works of the City of Chicago, delivered an address of welcome on behalf of the Mayor of the City of Chicago, as follows:

Mr. President, and Gentlemen of the American Concrete Institute: I would much prefer to remain and listen to your interesting proceedings than to hurriedly tell you that you are welcome, and withdraw, but the press of necessity will not permit. I am very much interested in all of the matters which will be discussed at your meetings. I am here, however, on behalf of the Mayor of Chicago, Hon. Carter H. Harrison, to present his compliments to the Convention, and his regrets that he could not be here in person. When I say that we hope your deliberations will result in great good to you, we want you to understand also that we feel that the results of your deliberations will be of great good to the world.

A few years ago, at the commencement of the administration of Carter Harrison, we had in Chicago miles upon miles of plank sidewalk in more or less good condition—principally less. As a result of those plank walks, we had judgments for personal injuries against the City of Chicago amounting to about $5,000,000, and we had to issue bonds in order to get the money to

pay. By virtue of being Commissioner of Public Works at that time I was also President of the Board of Local Improvements, with four subordinates in the Department of Public Works; and we proceeded to do something. I can assure you that we made ourselves mighty unpopular by promoting permanent and enduring walks; and that was really the introduction of sidewalks in the City of Chicago, as a policy.

I also had an earlier experience along the line of road construction. That subject appears to be promoted with great energy and considerable intelligence now, compared to what it was. We inherited mushroom pavements here, known as "cedar block pavements." If we had them today it would be impossible to run an automobile in the City of Chicago. For a few years we tried to build up the specifications for that material, but the very men who would have benefited by it, defeated it, the men who were furnishing much of the material which entered into the construction of those improvements. One of the points I want to make in reviewing my own experience—which is a matter of history in this city and may be gleaned from the records, is to warn the men who are furnishing material not to permit inferior material to leave their manufacturing establishments or their warehouses. If I were representing the capital invested in one of these large concerns, I would discharge immediately the salesman or shipping clerk who would let a particle of inferior material get out into use.

I regard the rapid strides made in enduring improvements, public and private, as entirely consistent with the great human progress of the last half of the nineteenth century and the beginning of the twentieth century. Had this character of improvement been known 100 years or more earlier, and had we the knowledge and the means to make our first investments on an enduring basis, our present struggles for existence would not be quite so energetic. The generations to follow will be the beneficiaries of the work that is being done now and the studies that are being made by you men today. Enduring private and public improvements mean more than mere profits to the men who promote in a scientific manner the things that enter into human economics; I consider such men to be as great benefactors of the human race as are the students of any science known to humanity. Therefore, Mr. President and Gentlemen, in the name of the Mayor, I want to bid you welcome, and hope that your deliberations will result in great benefit to you, as we know they will to the human race. We in Chicago are interested in all of these questions. We also in our governmental experience have had some struggles trying to build up efficiency in public affairs. Public improvements have served as an active agency in doing that. They have served as a means of applying human effort, directing the effort of men, building up their pride and interest in affairs, so that now our artisans are beginning to understand that they may take pride and interest in their work. In our early experience the artisans were simply hirelings, merely interested, apparently, in getting on the payroll. The artisans of this country must be inspired with a pleasure, a pride and an interest in their work, just as much as there is in fine art. We had a recent experience along that line in the construction of a water tower. We changed our plans, so that instead of the bricklayers and cement men

being induced to speed their work without regard to efficiency of the work itself, we had our men work by the day, and simply indicated that we wanted results; and a comparison of the work done by the two classes of men was most remarkable. The work done by the men who were interested in their work had line and finish, that any layman in passing would notice; but the other work was such that a taxpayer would be apt to use profane language about. Therefore, in studying lines of efficiency and in getting results, material men particularly, as well as our leading artisans and teachers, I believe should also think of things that will inspire the laborer to find an interest and take a pleasure in the result of his labor, outside of the payroll. When that situation becomes possible you will find that work will be generally much more satisfactory and I do not believe that it will detract from the profits. I thank you.

The President responded:

On behalf of the American Concrete Institute, Mr. McGann, I thank you for your kindness in personally welcoming the Institute on behalf of the Mayor of Chicago. Your address contains much of interest which we have been very glad to have you present for our consideration.

The following Committee on Resolutions, appointed by the Board of Direction, was announced by the President:

William K. Hatt, Lafayette, Ind.
P. H. Bates, Pittsburgh, Pa.
J. P. Beck, Chicago, Ill.
E. J. Moore, New York, N. Y.
A. L. Johnson, Buffalo, N. Y.,

also the following Committee of Tellers:

Lewis R. Ferguson, Chairman, Philadelphia, Pa.
L. S. Bruner, Montreal, Canada.
C. K. Arp, Chicago, Ill.

The following papers were read and discussed:

"Review of Present Practice in Concrete Road Construction," by Percy H. Wilson.

"Reinforcing Narrow Concrete Roads," by John W. Mueller.

A paper on "The Service Test Concrete Road in Philadelphia," by William H. Connell, was read by Assistant Secretary Fish.

The Convention adjourned until 3 P. M.

SECOND SESSION, TUESDAY, FEBRUARY 9, 1915, 3 P. M.

President Richard L. Humphrey in the chair.

The following papers were read and discussed:

"Cost of Construction and Maintenance of Concrete Roads," by H. J. Kuelling.

"The Construction of Integral Curbs," by Charles E. Russell.

"Comparative Cost of Concrete Roads," by Percy H. Wilson.

The paper on "Concrete Roads and Frost Action," by Andrew M. Lovis, was read by Assistant Secretary Fish.

The paper on "Organization and Methods of Constructing Concrete Roads," by William Acheson, was read by title.

The report of the Committee on Concrete Roads, A. N. Johnson, Chairman, was presented by its Secretary, William M. Kinney.

The Convention considered the report of the Committee in detail, made some amendments, and agreed that the specifications for alleys and the final consideration of the Committee report should come up at the evening session.

The Convention adjourned until 8 P. M.

THIRD SESSION, TUESDAY, FEBRUARY 9, 1915, 8 P. M.

President Richard L. Humphrey in the chair.

The Convention resumed the discussion of the report of the Committee on Concrete Roads.

The report of the Committee as amended, with the exception of the specifications relating to reinforcement, was adopted and ordered sent out to letter ballot.

The following papers were read and discussed:

"Test of a Reinforced Concrete Slab Bridge," by E. B. McCormick.

"The Use of the Microscope in Examining Concrete, with Special Reference to its Use in Sea Water," by Nathan C. Johnson.

"Standard Designs for Concrete Highway Bridges and Culverts," by E. B. McCullough.

The Convention adjourned until Wednesday, February 10, 1915.

FOURTH SESSION, WEDNESDAY, FEBRUARY 10, 1915, 10 A. M.

President Richard L. Humphrey in the chair.

The report of the Committee on Standard Specifications for Concrete Highway Bridges and Culverts was presented by its Chairman, Willis Whited.

The report of the Committee on Concrete and Reinforced Concrete was presented by its Chairman, A. E. Lindau.

The discussion of this report was made the order of business at the session, Thursday morning.

The Convention adjourned until 3 P. M.

FIFTH SESSION, WEDNESDAY, FEBRUARY 10, 1915, 3 P. M.

President Richard L. Humphrey in the chair.

The report of the Commitee on Nomenclature was presented by its Chairman, Frank C. Wight.

The report was ordered to be published in the JOURNAL, and come up at the next annual convention for action. In the interim, the Committee was instructed to co-operate with other Committees of the Institute and, if possible, with Committees of the American Society for Testing Materials.

The report of the Committee on Insurance, J. P. H. Perry, Chairman, was read by Secretary Krauss.

The papers on "The Design of Concrete Bins for the Storage of Cement," by Leonard Wesson, and "The Design of Wall Columns and Wall Beams," by Edward Smulski, were read by title.

The Committee on Concrete Roads, presented a proposed specification for reinforcement which was referred to the Committee for consideration and report at the next convention.

The following papers were read and discussed:

"Design and Construction of the Massachusetts Institute of Technology Buildings," by Sanford E. Thompson.

"Tests on Egg-shape and Circular Reinforced Concrete Sewer Pipe," by Albert Goldbeck.

The paper on "The Manufacture and Laying of Concrete Sewer Pipe," by Henry T. Shelley, was read by Mr. Goldbeck,

The paper on "Reinforced Concrete Stands, Stadia and Bowls," by Charles W. Leavitt, was read by Assistant Secretary Fish.

The Convention adjourned until 8 P. M.

SIXTH SESSION, WEDNESDAY, FEBRUARY 10, 1915, 8 P. M.

President Richard L. Humphrey in the chair.

The Annual Address of the President, entitled "The Progress of a Decade," was delivered by Richard L. Humphrey.

The following papers were read and discussed:

"Basis of Current Practice in Design of Reinforced Concrete Structures," by C. A. P. Turner.

"A Critical Review of Current Practice in Reinforced Concrete as Embodied in Building Regulations and the Joint Committee Report," by Edward Godfrey.

The Convention adjourned until Thursday, February 11, 1915.

SEVENTH SESSION, THURSDAY, FEBRUARY 11, 1915, 9.45 P. M.

President Richard L. Humphrey in the chair.

By unaminous consent, the business session was deferred until later.

The report of the Committee on Cement Products was presented by its Chairman, C. K. Arp.

The Convention ordered that the recommended practice for cement pipe and drain tile and the specifications for cement posts be received as information to come up for discussion at the next convention.

The revised Recommended Practice for Concrete Architectural Stone, Building Block and Brick was adopted as amended and ordered sent to letter ballot.

The paper on "Cement Roofing Tile," by J. S. Freund, was read by title.

The paper, "A New-Old Theory for Reinforced Concrete in Bending," was presented by L. J. Mensch.

The Secretary presented an amendment to Article IX, Section 2 of the By-Laws, as amended, to read as follows:

"The annual dues of each member shall be $10.00."

The amendment was adopted and ordered sent to letter ballot.

The Secretary presented the Annual Report of the Board of Direction, which was accepted.

The report of the Tellers was presented by its Chairman, Lewis R. Ferguson.

The President announced the following officers duly elected, to assume their respective duties at the close of the Convention:

President, Leonard C. Wason, Boston, Mass.
Vice-President for two years, William K. Hatt, Lafayette, Ind.
Vice-President for one year, Henry C. Turner, New York, N. Y.
Treasurer, Robert W. Lesley, Philadelphia, Pa.

Directors:
First District—William H. Ham, Boston, Mass.
Third District—Ernest Ashton, Allentown, Pa.
Fourth District—Alfred Lindau, Chicago, Ill.
Fifth District—William Anderson, Cincinnati, Ohio.

Mr. Robert W. Lesley stated that "the announcement today marks the eleventh election by the Institute of a president. It marks the retirement of our President for ten years—ten years more or less—a great deal more than less in the hearts of the members of this Institute. It is true that under our By-Laws we have no provision for honorary members, we have no provision of an emeritus president, we have no provision for an honorary president, but it is probably very true that if we had any one of these offices, we might strike a new precedent and fill the appropriate one. Acting on my own initiative rather than the approval of this Institute, it seems to me that there comes in the tide of the affairs of life extraordinary occasions; and while By-Laws and ordinary regulations may always govern in ordinary cases, it seems to me the retirement of an extraordinary president would require some extraordinary action; and while this Convention cannot and would not if it could violate its own By-Laws, it certainly can in some way indicate to the incoming Board that there should be some consideration of the faithful services that

Mr. Humphrey has rendered this Institute, and that in distinguishing him this Institute would be distinguishing itself."

The President asked Vice-President A. N. Talbot to take the chair.

The motion offered by Mr. Lesley that "it is the sense of this meeting that the question of the election of our retiring President to the position of Honorary President be left to the incoming Board for their consideration and action," was unanimously adopted.

President Humphrey resumed the chair.

The Convention discussed the report of the Committee on Concrete and Reinforced Concrete.

The Convention adjourned until 3 P. M.

EIGHTH SESSION, THURSDAY, FEBRUARY 11, 1915, 3 P. M.

President Richard L. Humphrey in the chair.

An address on "Concrete: A Medium of Æsthetic Expression," by Irvine K. Pond, was presented by his brother, Mr. Pond.

The paper on "The Fireproof Home," by R. P. Stoddard, was read by title in the absence of its author through sickness.

The paper on "A New and Simple Method for Securing Dustless Concrete Floors," was presented by P. M. Bruner.

The report of the Committee on Treatment of Concrete Surfaces was presented by its Chairman, L. C. Wason.

The report was adopted and ordered sent to letter ballot.

The discussion of dustless concrete floors was opened by L. C. Wason.

The Convention adjourned until 8 P. M.

NINTH SESSION, THURSDAY, FEBRUARY 11, 1915, 8 P. M.

President Richard L. Humphrey in the chair.

An address on "Concrete in Metropolitan Construction" was presented by Charles E. Fox.

The report of the Committee on the Edison Fire was presented on behalf of its Chairman, Cass Gilbert, by E. J. Moore, Secretary.

Mr. T. L. Condron presented a paper on the "Repairs to the Buildings of the T. A. Edison Plant."

Mr. N. C. Johnson presented a discussion showing the application of the microscope in the study of the effect of heat on concrete.

The Convention adjourned until Friday, February 12, 1915.

TENTH SESSION, FRIDAY, FEBRUARY 12, 1915, 10 A. M.

President Richard L. Humphrey in the chair.

The paper on "Some Principles of Design as Applied to Concrete Houses," by Charles E. White, Jr., in the absence of its author, was read by title.

The paper on "Contractor's Equipment, Austin-Nichols Warehouse," by T. L. Smith, was presented by E. J. Moore.

The paper on "Mechanical Plant for Handling Concrete" was presented by W. P. Anderson.

The paper on "Synthetic Stone in Catskill Aqueduct Buildings," by H. Lincoln Rogers, was read by Assistant Secretary Fish.

Mr. Ralph R. Shainwald, Jr., described an apparatus for determining permeability of cement mortars.

The paper on "Concrete Forms for the Catskill Aqueduct," by Alfred D. Flinn, was presented by Assistant Secretary Fish.

The paper on "The Strength of Concrete Forms," by Harrison S. Taft, was presented by Secretary Krauss.

The Convention adjourned until 3 P. M.

ELEVENTH SESSION, FRIDAY, FEBRUARY 12, 1915, 3 P. M.

President Richard L. Humphrey in the chair.

The following papers were read and discussed:

"Some Further Results Obtained in Investigating the Properties of Portland Cement having a High Percentage of Magnesia," by P. H. Bates.

"Mixing, Curing and Placing Concrete with High Pressure Steam," by Harold P. Brown.

Mr. Tubesing explained a cost card which he had developed for concrete work.

The report of the Committee on Aggregates, Sanford E. Thompson, Chairman, was presented by its Secretary, Cloyd M. Chapman.

The report of the Committee was accepted.

The report of the Committee on Resolutions, William K. Hatt, Chairman, was presented on behalf of the Committee by P. H. Bates, as follows:

WHEREAS, The field of the activities of the American Concrete Institute has been greatly enlarged during the past year by dues from contributing members, and by donations from individuals and corporations interested in the work, therefore, be it

Resolved, That the American Institute hereby express its thanks to those who have thus generously aided in the work, and that the Secretary be directed to send a copy of this resolution with a personal letter to each contributing member, and to each individual firm or corporation from whom donations have been received.

WHEREAS, The Standards of the American Concrete Institute include specifications for forms of concrete construction, which, if followed, will improve the state of this art, reduce loss of life and property by fire, and generally improve the standard of building construction in America, be it

Resolved, That these facts and these standard specifications referred to be called to the attention of State and Municipal Building Departments, and the various organizations of fire underwriters in the United States and Canada, with the request that these standards receive recognition in existing laws and in schedules for estimating insurance rates.

Resolved, That the thanks of the American Concrete Institute be hereby extended to the members and others who have added to the success of this Convention by the preparation and presentation of papers to the members of the local sectional committees, and to the technical and trade press for co-operation and assistance in furthering the interests of this Institute.

Resolved, That the American Concrete Institute express its lively appreciation of and hearty thanks for the work of the retiring President, Mr. Richard L. Humphrey, who for ten years has labored with intelligent devotion and untiring efforts in directing the growth of and obtaining support for this organization, and bringing the organization to extended and important public service in its peculiar field of work to establish standards for practice in concrete design and construction.

This report was unanimously adopted.

The President made the following address:

This, gentlemen, completes the work of the Eleventh Convention and also my duties as your President. It has been a long service, and I want to express to you again my personal appreciation of the cordial co-operation which you have always accorded me and the patience that you have sometimes manifested in my execution of the duties of President. I am in no sense retiring from the Institute. I pledge my services in the rôle of past-President, in the same measure that I have given as President, and finally I want to say to you, gentlemen, that there is no member of this Institute whom it gives me greater personal pleasure to welcome to the office of President than Mr. Leonard C. Wason. I will ask Mr. Anderson and Mr. Moore to kindly escort the President to the chair.

Messrs. Anderson and Moore escorted President Leonard C. Wason to the chair.

President Wason:

I know you do not want to stay for a speech and I am not going to take the time to make one. This is not officially where I begin, because the new officers begin their duties at the close of the Convention, and you have one more session on the program, namely, the banquet, and not until that is over is the Convention closed. I simply stand up here to be looked at for a moment. You can imagine what ought to be said, because I know you wish to go, and the Convention, therefore, stands adjourned if you please, until this evening at 7 o'clock.

THE ANNUAL BANQUET, FRIDAY, FEBRUARY 12, 1915, 7 P. M.

Toastmaster, Douglas Malloch.

Addresses were made by Albert Reichmann, Past President, Western Society of Engineers, and Henry Walter Graham.

THE PROGRESS OF A DECADE.

Annual Address of the President.

By Richard L. Humphrey.*

The marvelous increase in the use of Portland cement during the first decade of the life of this organization has exceeded the dreams of the most optimistic members present at the time of its formation. The use of concrete has developed amid bitter opposition, criticism and abuse to the honored position of one of the most important materials of construction. What the next decade will bring forth no optimist among us today can possibly foresee, for great as has been the development in the last decade, the next decade will undoubtedly show that our knowledge and application of concrete at the present time is as crude and limited as it was at the time this organization came into existence. This transition, from a period where most conservative constructors were content to allow others to acquire experience in the use of concrete and reinforced concrete (and these materials were first used by such progressive pioneers as had the courage of their convictions and the foresight to recognize possibilities), to the present time covers one of the most remarkable periods of development in the history of building materials; more particularly will this be true of the next decade, when the constructor has acquired such confidence in this remarkable material as to no longer use it in imitation of other materials, but instead as a plastic material which readily lends itself to varied conditions of use, either for structural or for ornamental purposes. Its well-established qualities for ornamental purposes need no comment; the speaker has had the honor to bring to the attention of this Institute the possibilities of concrete from an artistic point of view, in describing some of the beautiful structures to be found abroad and pointing out the increasing number of such structures in this country.

* Consulting Engineer, Philadelphia, Pa.

The excellent fire resistive qualities of concrete which have resulted in an increasing popularity for fire proofing purposes, emphasized by each successive fire, alone establish it as one of the important materials of construction. Unfortunately, the constructor, in his conservatism, seems to go beyond the bounds of common sense and reason and expects concrete to possess, in measured degree, qualities which are expected of no other material. The Edison fire is an exemplification of its fire resistive qualities. The critics who view the reinforced concrete buildings that withstood so satisfactorily the extraordinary conditions surrounding this fire, look at the damage done to concrete and in so doing lose their bearings; they fail utterly to consider, first, that no other material could have given so excellent an account of itself as concrete, and, second, that no material is fire proof, as its fire resistance is only relative. No material can resist a fire of sufficiently great intensity or duration. Critics view with complacency the complete wreck of brick wood-joisted structures and of all buildings other than those of concrete. The marvel in the behavior of these buildings of concrete is not that they were damaged, but that they should have withstood the extraordinary conditions so well.

The past decade has probably been the most critical in the history of the cement industry, and there is no member capable of fully realizing the vital importance of the part this Institute has played in its development. Its educational work, its conventions, its expositions, and particularly its committee work in preparing recommended practice and standard specifications, have guided the use of cement along safe and practical lines and assured the permanency of the construction in which this material is used. It is only necessary to go abroad to appreciate how very much the European organizations watch and follow the recommendations of this Institute; for America and the American Concrete Institute are today in the very forefront as exponents of the possibilities of concrete. The European constructor, as the speaker has pointed out in previous addresses, is more advanced in that he has a better conception of the possibilities of concrete than has the constructor in this country, because the former thinks of it as a plastic material, so designs the structure in which it is used and does not attempt to imitate other building materials.

The use of a binding material for masonry structures extends back to early Biblical days, and the use of some form of lime to Roman antiquity. The development of the present hydraulic binding material from the ordinary fat limes, puzzuolana cements, hydraulic limes and cements, is of great interest. We attribute the durability of Roman and other structures several thousand years old to the remarkable qualities of the binding material used in their construction, failing to realize that these structures of concrete in and about Rome have survived, in a favorable climate, and that the induration of the mortar is the result of centuries. How much of this early concrete was destroyed even under these favorable conditions is difficult to say. It was the supposed superiority of this binding material that led the early investigators of the eighteenth century to seek to recover a supposed lost Roman art.

"Necessity is the mother of invention," and so the modern Portland cement resulted from the necessity for a cement, which would harden properly under water, for use in rebuilding the Eddystone Lighthouse. The use of reinforced concrete had its birth in the latter part of the eighteenth century with a gradual development during the nineteenth, which reached its present great development during the twentieth century. The production of Portland cement was 26,505,881 barrels for 1904 and 88,514,000 for 1914, or 3,000,000 less than for the previous year. These ten years coincident with the life of this organization cover a decade of the greatest activity in the use of cement in the history of the industry. Considering the extraordinary circumstances which mark the progress of events during 1914, viz., the inauguration of new governmental policies, affecting our life under a protective tariff, affecting our banking system, and affecting our railroads and other business organizations, and abroad of the greatest war of history—the consumption of Portland cement during the year was most remarkable, especially since the completion of the Panama Canal ended the annual consumption of approximately 1,000,000 barrels. The speaker is of the opinion that, in the near future, with an end to the period of retrenchment which has characterized the progress of business in this country since 1907, the repressed prosperity thus released will result in such an increased consumption of Portland cement as to

bring the curve to the position of progressive increase it must have occupied had the business conditions remained normal.

As a result of this increase in production during the past decade, this country has become the largest producer of Portland cement in the world; our present production almost exceeds the combined production of all the other countries.

At no time in the history of the building industry has the constructor had at his disposal a cement possessing the unexcelled qualities of the American Portland cement.

The use of Portland cement in sidewalks in this country was as early as 1882, and at the time of the formation of this Institute the art was considerably developed and cement sidewalks, having outlived the objections to them, were in general use and were generally acknowledged to be the most desirable. There was, however, a great diversity of opinion as to the proper method of construction, and many bad sidewalks were laid through ignorance as to correct methods. One of the first committees appointed by this organization was that on Sidewalks and the Proceedings of the earlier years are filled with interesting discussions by sidewalk constructors, showing considerable diversity of practice in different parts of the country. This discussion and interchange of views as to the correct practice resulted in the present standard specifications of this Institute, which are universally accepted; it is rare now that one finds a bad sidewalk being laid, and when one does it is generally being laid by an inexperienced constructor.

As has been previously pointed out the need of a cement for use in the masonry of locks and other structures connected with canals led to the establishment of a plant for its manufacture in the State of New York in 1818. The development of the use of this material in connection not only with canals but hydraulic works has been quite remarkable. The speaker last year pointed out the wide diversity of structures in which this material was being used, which was justification for the statement that its use for this purpose was practically unlimited and that it has proved itself to be one of the most desirable materials for the construction of hydraulic work. The greatest and most important application of this material was in the Panama Canal, actively started and built during the existence of this Institute. It is fair to state that

concrete made possible the efficient construction of this canal; through its use the cost was greatly reduced and the time of construction materially lessened.

There are a number of examples of the early use of concrete in the construction of sewers, some of which are more than thirty years old. However, concrete was not used to any great extent for this purpose until after this organization was formed. Experience has led to decreased cost and increased skill in making dense, impervious pipe, and has resulted in its successful introduction in municipalities; in this use we are far behind the foreign manufacturers because cement sewer pipe is much more extensively used throughout Germany and other foreign countries. A paper to be read before this Convention, describing the use of cement sewer pipe in the City of Philadelphia, shows the great possibilities for this type of construction. Philadelphia has used concrete in its larger sewers for many years but has been using other materials in its smaller sewers; the experience which has proved concrete to be the most satisfactory and the cost of installation to be only two-thirds of that for brick, assures for it a pre-eminent rank for all kind of sewer construction.

Cement pipe has come into general use for drainage and irrigation purposes; many members of this Institute are engaged in its manufacture and there has been much discussion at our conventions as to proper methods of manufacture and the tests to which it should be subjected; the first manufacture of cement drain tile by power machinery was in a small factory in Iowa, in 1905; the industry now produces over a quarter of a million lineal feet, representing nearly ten million dollars. There is no doubt that cement drain tile is more durable than other tile and generally less expensive.

At the time of the birth of this organization the use of reinforced concrete in buildings was limited; only a few large buildings had been constructed and there was considerable doubt as to its value for this purpose; at present there are a very great number of reinforced concrete buildings and they are no longer regarded with curiosity and suspicion but are proved to be most desirable as regards first cost, low cost for upkeep, and resistence to fire. The report of the Committee on Insurance several years ago stated that of the several hundred buildings reported on

twenty-five per cent of the owners did not think it was necessary to carry insurance on the building but only on its contents.

The use of concrete for bridges extends back many years previous to the formation of this Institute. It was, however, during the existence of this Institute that some of the very best examples of the art were built, both in this country and abroad. This Institute has undoubtedly been a potent factor in stimulating the artistic treatment of concrete and the speaker is very glad to state that there are increasing numbers of artistic structures being erected in this country; they fully equal those structures abroad which he has had occasion to illustrate in his several annual addresses. There is probably no material today so well adapted for bridge construction as concrete, since it fulfills three essential requirements; first, economy in the initial cost; second, low cost, and generally no cost, for maintenance, and third, the possession of those plastic qualities which readily lend themselves to any design. In our permanent highways which are now rapidly developing, reinforced concrete bridges will be very generally used. In railroad work, particularly in Western lines, concrete is one of the most valuable materials available. The ability to gather locally all the material required (except the cement and reinforcement), has made possible many structures at very low cost; beside it has eliminated the necessity of maintenance which is generally a matter of considerable importance to these railroads. Even in Eastern railroads, concrete, because of its permanency, is replacing structures of other materials; in the City of Philadelphia may be found some recent examples of the use of concrete in railroad work, notably where the Pennsylvania Railroad crosses the Schuylkill River and Broad Street, which exemplify its artistic qualities and in my opinion mark the beginning of a much more extensive application. The Broad Street girder bridge, which girders are usually built of steel and unattractive, is, through the use of concrete, rendered inconspicuous since the embellishment of this bridge in concrete is pleasing to the eye and entirely attractive.

In the removal of grade crossings in the City of Chicago the development of the flat slab type of construction and innumerable other applications of concrete have given during the last few years an extraordinary impetus to the use of concrete in this field of construction.

In the works of the Reclamation Service in the far West concrete has again proved of extraordinary value in the isolated localities in which most of these structures must be erected; it is said many of these could not have been built except through the use of concrete. It is certain that the amount of money expended by the Reclamation Service in the construction of its important works has been very materially reduced, and they have been completed in much less time through the use of this material.

During the earlier conventions of this Association the speaker pointed out the value of concrete for roadways, and his endorsement of this use of concrete was met with skeptical comment. No one cared to express a favorable opinion, but it was evident that all present thought that such views were altruistic. His opinion, repeated at subsequent conventions, led to a similar feeling, and one of the daily technical papers in the report of the sixth convention, stated that "President Humphrey seems to be a firm believer in cement as a road material. If it does not work out right, it is the fault of the workman," and in the report of the seventh convention remarked, "President Humphrey still believes in concrete roads."

TABLE 1.—SHOWING GROWTH IN CONSUMPTION OF PORTLAND CEMENT FOR CONCRETE ROADS.*

	Square yards.	Barrels of Cement.
Prior to 1909	862,880	
1909	416,460	104,000
1910	1,009,120	243,000
1911	2,014,740	513,000
1912	5,556,656	1,850,000
1913	8,576,160	2,880,000
1914	14,997,550†	4,499,000

In Table 1 it is shown that the development in the use of Portland cement for concrete roads beginning with a consumption of about 104,000 barrels in 1909, has reached the extraordinary consumption of nearly 5,000,000 barrels during the current year. The concrete road has proved most economical as to the first cost and maintenance, and most desirable from the point of service. The coming of the automobile has obliged us to consign our

* Compiled by the Association of American Portland Cement Manufacturers.
† Of this amount, 4,109,900 square yards were placed in city streets.

highly developed knowledge of the art of road construction, to the waste paper basket, and to apply ourselves to the development of a new roadway to meet the new conditions resulting from its introduction. It is in this field that concrete gives the best account of itself as to service and economy in cost of construction and maintenance. At the instigation of your President a Committee on Concrete Roadways was appointed in 1908, and it was with difficulty that a chairman was secured. The Institute specifications for concrete roadways are now the standard for this country, are followed closely abroad and experience in their use has demonstrated that they are the best available.

The Institute has been instrumental also in the development of concrete fence posts, telephone and telegraph poles. When the matter was first discussed before this body, people looked askance at the idea of making a fence post of concrete, not only with reference to its strength, but particularly with reference to its cost. The permanency of the post, its rigidity (which reduces greatly the cost of maintenance), and particularly the decrease in the cost of manufacture, has led to its rapid introduction; at the present time the cement post is no longer an experiment or a curiosity, for excellent examples of its use can be found in all parts of the country.

The telephone and telegraph pole is being gradually introduced. The discussion of these poles before this organization, its approval of them and the papers which have been presented describing where they have been successfully used, all indicate that their use will be much greater in the future than in the past.

It would be impossible within the limits of this address to describe the many activities of this Institute affecting the use of cement; but two more references will be given.

The speaker wishes to point out that some years ago reference was made to the reinforced concrete railroad tie, and when the matter was discussed he expressed the opinion that the reinforced concrete tie was the tie of the future. Little headway is being made in its development in this country. Numerous ties are in use, but the cost is high in comparison with their life, and particularly objectionable is the rigidity of the resultant roadbed which the motive power man considers detrimental to the equipment operated over it. There are, however, a number of rein-

forced concrete ties in successful use. Abroad—especially in Italy—the ties are being used in large quantities. In that country, where more than a half million ties are in use, the lack of a cheap wood or metal tie has increased the economy of the concrete tie; those who are interested in the development of the reinforced concrete railroad tie are directing their energies to so designing the reinforcement as to take up the stresses which come upon it and prevent failure which is usually by crushing along the inside of the rail. The introduction of an elastic cushion between the rail and the tie has resulted in a less rigid roadbed and has tended to absorb the shock of passing trains. The speaker is decidedly of the opinion that it will be only a short time before a thoroughly efficient tie will be developed, and the use of reinforced concrete railroad ties will be as extensive as is the present use of concrete for roads and other purposes.

The Institute, as will be shown later, has been very much handicapped for funds to carry on its work, and for this reason such investigative work as it has been able to do has been all the more commendable. Many committees have been conducting special investigations, but the most important is the Committee on Reinforced Concrete and Building Laws, which has contributed some of the most important information on the strength of reinforced concrete floors. Some of the first buildings in which floor load tests were efficiently applied were under the auspices of this committee, and the reports and discussions to be found in the Proceedings constitute the best available information on this subject. The Committee reports at this Convention one of the most important set of tests of reinforced concrete columns that has ever been made; a series of tests that will contribute much to the available information; the large size of these columns (commensurate with working conditions), gives to the results of these tests the same value as the results of the load tests applied to the reinforced concrete buildings.

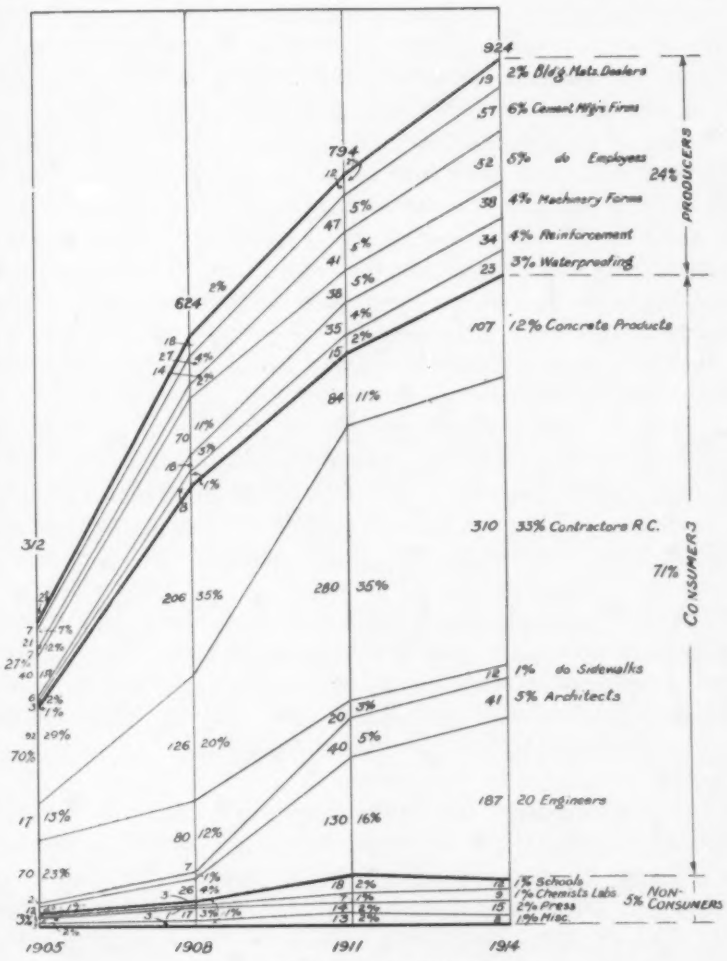
Although this organization has produced more than eighteen standards and recommended practice, its work has only just begun. The existing standards must be revised, new ones developed, and there never was so much need for work of this character as at the present time. Permanency is the keynote of concrete and reinforced concrete; to secure this permanency, con-

crete must be properly and intelligently used, and the knowledge which will make this possible can only be secured through the development of standards embodying the latest experience in the use of the material. This Institute in its technical endeavors, a record of which is in the ten volumes of Proceeding which have been issued, has acquired a high standing and an honorable place among the technical societies of this country and Europe.

In describing the activities of the Institute for the past ten years it seems to the speaker only fair to place on record the story of how these accomplishments have been made possible. Few members of the Institute are aware of the character of its membership, of the value of the service rendered per member, of the income per member, and other vitally important matters which you entrust to your Board of Direction and which are briefly recounted in its annual reports.

This organization was started in 1905 as a result of the activity and foresight of the Cement Block Machinery Manufacturers. The primary purpose was to develop the use of the cement hollow building block along intelligent lines; this purpose was largely commercial. Because of the conditions surrounding its formation, the organization was called, after much discussion, the National Association of Cement Users. The speaker was summoned from his bed on January 19; 1905, at 3 o'clock in the morning, to the Columbia Club in Indianapolis, to a meeting of the organizing committee who were deadlocked over the selection of a representative of a commercial organization for President; at this meeting the speaker accepted the Presidency, which was unanimously offered to him without conditions, with no expectation that he would serve for more than one year. The development of this organization, which led to a change in its name to the American Concrete Institute, was not necessarily the result of a change in the character of its membership. Many in this country had a feeling that the National Association of Cement Users was a trade organization, and since this was entirely contrary to its real functions, it was deemed desirable to change the name to its present one, which is believed to more clearly typify its character and activities. Diagram No. 1 shows that even at the time of its organization, the consumers of cement were greatly in excess of the producers of the various materials and appliances

required in connection with its use; this relationship has since changed until at the present time the users of cement constitute 76 per cent of its members, and the producers of cement, machin-



NO. 1.—CHARACTER OF MEMBERSHIP.

ery, reinforcement and other supplies constitute 24 per cent. This Institute is, therefore, a technical organization not dominated in any way by commercial interests; its work is educa-

tional, in developing correct practices and standard specifications and in disseminating a knowledge of the proper uses of cement. The Institute is a member of the American Society for Testing Materials and the National Fire Protection Association, and its representation on important committees of these societies has been most beneficial. The attitude of its representatives in not asking for more than a square deal, of being willing to recognize that reinforced concrete is not perfect and has its limitations, and insisting that it should be properly applied and used wherever possible, has been most helpful to the industry. The speaker thinks this organization may look with pride on the fact that in its ten years of existence it has never permitted itself or its members, at its Conventions or in its Proceedings, to assail any other building material, but has confined itself to an exposition of the merits of concrete. The speaker believes this attitude, and this course of procedure, has made many friends and has done much to further the rapid use of concrete.

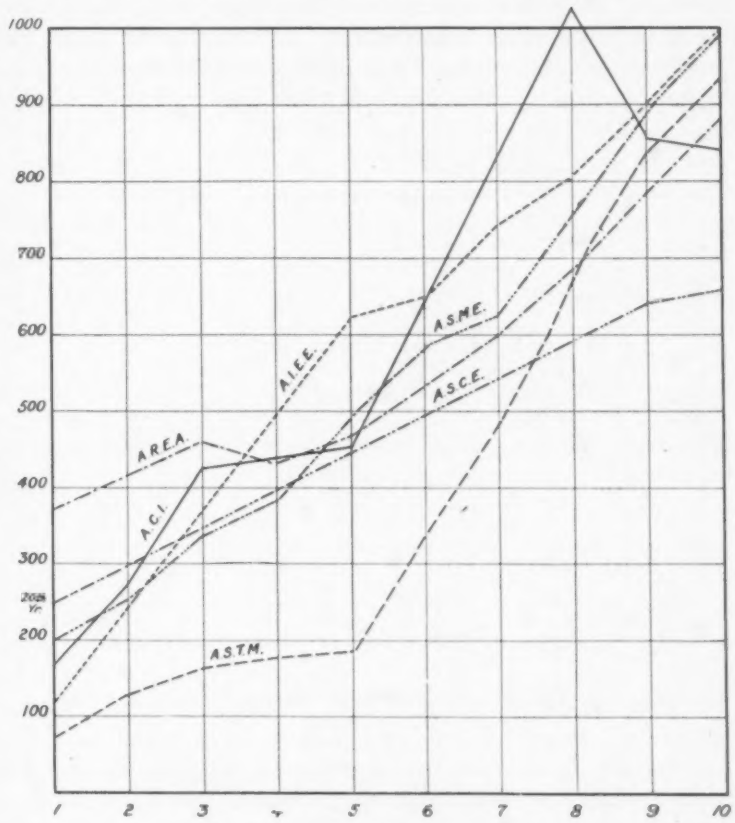
The standards and recommended practice promulgated by this Institute have exerted a wide influence in the betterment of current practice in the use of cement. This influence has been reflected in building regulations in various portions of the country, in which have been incorporated many of the recommendations of this Institute.

The reports and papers presented before the annual conventions have received a wide publicity through their republication in the technical press both in this country and abroad, which has been productive of much good both from an educational and a commercial point of view in stimulating a proper use of cement.

The Proceedings have permanently recorded the result of these deliberations, but the most important effect has been the interchange of practical experiences by those in attendance, not only on the floor of the convention, but during the convention. Those who recall the earlier conventions realize how eagerly these conventions were attended by those who sought the practical experience which was not to be acquired in any other way. During the decade covering ten conventions, 236 papers and 56 Committee Reports have been presented and make ten volumes of Proceedings, totaling 5,858 pages. The dues of the members

have remained $5 a year, which have been returned to the members in the value of these Proceedings.

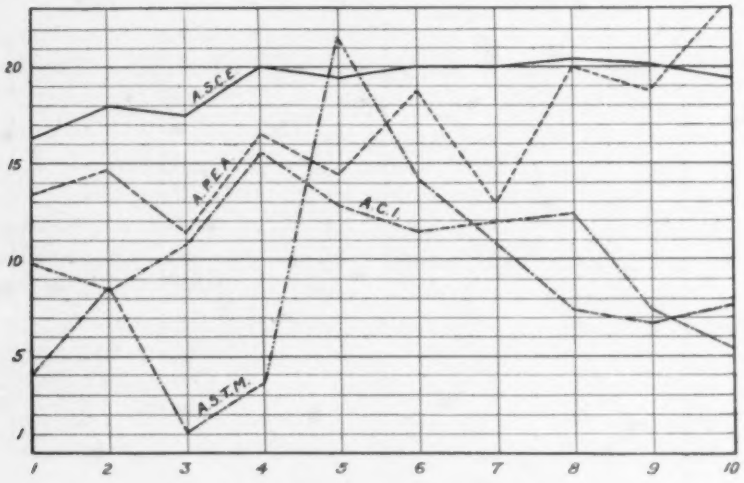
The Cement Show has been a most potent factor in popularizing the use of concrete; none can properly gage this influence. Hundreds of thousands of people not directly interested in



NO. 2.—GROWTH IN MEMBERSHIP.

concrete have visited these shows and carried away ideas which have subsequently borne fruit in an increased use of cement. The First Cement Show was held under the auspices of the National Association of Cement Users and annually thereafter, until 1907, when by mutual agreement the Cement Products Exposition Company co-operated with this Institute in holding

the annual Cement Show. It was never a desirable thing for a technical organization to manage a show which is in its very nature largely a commercial proposition; but in the pioneer days its work in this line was of the highest importance, and the Cement Show proved to be one of the most successful of the educational industrial expositions that have been undertaken. This Institute, therefore, can place to its credit the initiation and successful operation of the Cement Show for a sufficient number of years and on a sufficient scale to establish its ability in this direction.

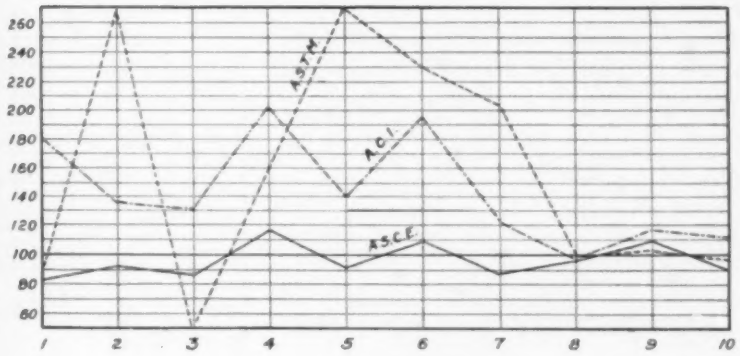


NO. 3.—COST OF SERVICE PER MEMBER.

Diagram No. 2 shows the growth in membership of this Institute in comparison with some of the leading National Societies, attention being particularly directed to the fact that the curve for the American Society of Civil Engineers begins at the twentieth year. It is interesting to note that the American Society of Civil Engineers, which was organized in 1852, held only a few meetings, and after three years of existence, there succeeded a period of twelve years during which time no meetings were held; the records of membership begin at the twentieth year. From this diagram it is evident that the American Concrete Institute

has shown for the first eight years a much more rapid growth than any other organization, and the members can view with pride the record of its achievement in this respect.

During the last two years the Institute has been mightily handicapped for funds, and it has not been possible to keep up the increased activity which would stimulate increase in membership. Indeed, under the strenuous conditions which have prevailed it has not been possible to carry on a campaign for membership for the reason that the funds were not available for this purpose. As a result of this enforced inactivity the number of members has decreased as shown in the diagram. As illustra-

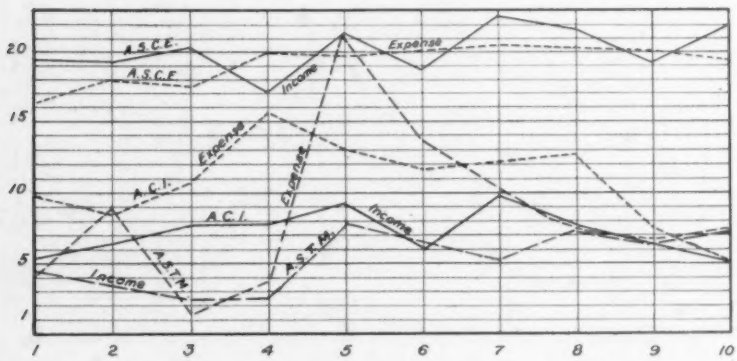


NO. 4.—RATIO = $\frac{\text{EXPENSE.}}{\text{INCOME.}}$

tive of the situation, Diagram No. 3 is presented which shows the expense and income per member for the American Society of Civil Engineers and the American Society for Testing Materials, for which information is readily available. Both the American Society of Civil Engineers and the American Society for Testing Materials, are now self-sustaining, the former having accumulated a great surplus, which is annually increased about $30,000. From this diagram you will observe that during the earlier periods of the existence of the Institute the receipts were considerably less than the expenses. In Diagram No. 4 is shown the ratio of the expenditures to the receipts for each member, and it may be seen that the American Concrete Institute compares favorably with

the other societies; that is, its management is fully equal to that of the other societies shown.

From Diagram No. 5 it is apparent that the expenses of the Institute are in excess of the dues and that these expenses are in excess of $10 per annum. The sale of the Proceedings, advertising and other sources of income, supplement these dues and reduce the deficit in the Institute funds. However, past experience has shown that the cost per member was in excess of $7 per annum and it was necessary to supplement the amount received from dues, by subscriptions, advertising and other means.



NO. 5.—INCOME AND EXPENSE PER MEMBER.

During the ten years the gross expenses of the Institute have exceeded $75,000. The revenue from dues has amounted to about $20,000. Exclusive of the over $17,000 special fund subscribed this year, there has been raised during this period $47,936.49, divided as follows:

Special contributions and subscriptions	$8,663.75
Sale of publications, advertisements, membership certificates	10,703.72
Contributing membership	2,540.00
Exhibition	18,747.27
Local subscriptions, account Convention	7,281.75
	$47,936.49

In other words, in the ten years during which the speaker has been President, over $63,000 has been obtained from sources other than the dues, for the support of the organization.

SUMMARY OF RECEIPTS AND EXPENDITURES OF THE AMERICAN CONCRETE INSTITUTE.

JANUARY, 1905, TO FEBRUARY 12, 1915.

RECEIPTS.

Dues	$19,431.94
Contributions and subscriptions	21,688.75
Sale of publications, advertisements and membership certificates	10,703.72
Convention	7,281.75
Exhibition	18,747.27
Miscellaneous	359.53
	$78,212.96
Unpaid subscriptions	4,425.00
	$82,637.96

EXPENDITURES.

Office Expenses:	
Salaries and rent	$18,474.83
Postage, printing, stationery, etc	7,320.35
Equipment	522.44
Miscellaneous expenses	1,607.50
Board of Direction and Committee expenses	1,854.44
Membership campaign	634.37
Publications, membership certificates, etc	22,706.62
Convention	7,664.95
Exhibition	10,395.79
Miscellaneous	2,118.67
Uncompleted publications	3,250.00
	$76,549.96

Your Board of Direction became convinced several years ago that an increase in the dues was highly desirable and it therefore recommended that they be increased to $10 per annum. As the matter did not meet with particular favor, there being a feeling that there were a large number of members who could not afford to pay $10 a year, whose membership would be lost through this

increase, your Board canvassed the opinion of the membership by letter-ballot. The result of this is given in Table No. 2, and from which it may be seen that on this question the membership was nearly equally divided. Your Board, therefore, deemed it inexpedient to raise the dues at that time. The financial condition of the Institute, however, did not improve and it became necessary, therefore, to undertake some plan which would insure its future existence and growth. Accordingly it was decided during the current year to raise a fund to care for the deficit and provide a sufficient excess to enable it to carry on the work necessary to place it in a position where it would be self-sustaining. This plan contemplated the employment of a Secretary who could give his entire time to the work at an increased salary; the

TABLE 2.

Result of Letter-Ballot on Increase of Dues.

	Yes	No	Total
Manufacturers	38	21	59
Small users	43	51	94
Large contractors	30	30	60
Engineers	70	55	125
Architects	5	13	18
Miscellaneous	4	4	8
Press	5	1	6
	195	175	370

task of raising $12,088 by special subscriptions was entrusted to your President, through whose efforts over $17,000 has been subscribed, and at no time in the history of the Institute has it been in such a strong condition financially. Today all its obligations to its members have been fulfilled; its debts have been paid, and the incoming Board of Direction has available a surplus to meet the expenses of the current year. The speaker is now fully convinced—as are all those who have given the matter consideration—that the dues should be increased to $10 a year, since no national society can successfully exist on annual dues of $5 per annum.

It is felt that the American Concrete Institute now occupies

a very important position in the cement industry; that it has more than justified the necessity for its existence and that it would be a calamity to permit it to lapse and possibly go out of existence from lack of adequate support. Everyone who is interested in the industry should become a member and thus give his support in the development of the industry. Such membership returns more than the value of the dues in the service rendered, but aside from this, each member should face the situation unselfishly and not measure the value of his membership by what he can secure for himself, but rather by his duty to the industry from which he obtains a livelihood. During the period when your officers were hopelessly trying to stretch the dues to cover the essential expenses, the organization and its expenditures were subjected to that critical analysis which always arises under such conditions; the fact that no substantial defect in its management could be found, and that the work done by the headquarters office was very much greater, and at a very much less cost per capita, than that of any other national society, is justification of the statement that the Board of Direction has done its best to successfully run the Institute on dues of $5 a year; and it is evident that it is not practical to operate on this amount, and, therefore, the increase in dues is imperative.

The Institute is engaged in selling service to its members; this service can be made efficient and will increase in amount, just in proportion as it is supported by the members and as the number of members increases. The Institute has unquestionably passed through an important decade in its existence and from now on its growth will undoubtedly be rapid; it will become stronger and more important as time goes on. It has been a great pleasure to serve this Institute and do all that was possible for its development.

The influence of the Institute is expected to be greatly increased through the publication of the JOURNAL, which made its initial appearance with the December number in 1913.

The purpose of this JOURNAL is to increase the activities of the Institute and maintain the interest of its members in the interim between Conventions in three ways: first through the circulation in smaller and more convenient form for current use of the reports, papers and discussions presented at the previous Convention,

and information concerning the work of the Institute and of its Committees; second, the publication of papers and discussions which have not been presented, although they may be the subjects for discussion at the Convention, and third, the preprinting of reports and papers to be presented at the Convention.

Beginning with the current March number, the JOURNAL will carry advertisements, the revenue from which is expected to cover, at least, the cost of its publication.

The Presidency was originally undertaken for the one year only, but conditions seemed to make it desirable, from the point of view of the needs of the Institute, that the speaker should continue as President, with the expectation each year that the conditions would so improve that another man could take up the reins of government. Ten years have elapsed under these conditions and the speaker trusts that the members of this Institute will feel that the service rendered has been an unselfish one, with no desire or thought of personal gain; but with the hope that the Institute could be made permanent, could be raised to a high position among the national societies of this country and placed in such a flourishing state that the future administration of its affairs would be not unduly handicapped by conditions which make efficient work difficult. When the speaker accepted the Presidency last year, he stated * * * "In accepting this election for the tenth time, I wish to give you warning, so you may have an opportunity for considering available candidates during the coming year, that I will not under any condition accept a re-election" * * * and that he believed at that time he foresaw the end of the difficulties which have confronted the Institute. It is his hope that this belief has been realized and he wishes to acknowledge his deep obligations to all the friends of this Institute and of himself, through whose generous co-operation it has been possible for him to realize this belief. The speaker, at the close of this convention will, with a feeling of relief, turn over to his successor the duties of President; this does not mean a severance of his connection with the Institute, since he will always be at its service and his best energies and endeavors will be directed to its development. He bespeaks for his successor the same generous support that you have accorded him; it would be unfair

not to acknowledge the support which his successor, as a member of the official family, has always given to the speaker during all these years of association. Mr. Leonard C. Wason has been a devoted supporter of this Institute and it is but just, in recognition of this devotion, that you should honor him with the Presidency.

REVIEW OF PRESENT PRACTICE IN CONCRETE ROAD CONSTRUCTION.

By Percy H. Wilson.*

The number of square yards of concrete pavement that were laid during the year 1914 amounted to about 14,000,000. This is almost as many square yards as the total previously laid. The number includes concrete streets and roads, as well as alleys. The reports are not complete, and probably never will be. In addition to the above, contracts were let for over 4,000,000 sq. yd., which makes the total yardage laid and contracted for during the year 1914 greater than a combination of that in all previous years. It may be of interest to you to know the increase in percentage of the number of square yards laid from year to year; in 1909 there were a little over a million; in all years prior to 1909 the total was about eight hundred thousand; 1910 showed an increase over 1909 of 140 per cent; 1911 showed an increase over 1910 of 100 per cent; 1912 showed an increase over 1911 of 175 per cent; 1913 showed an increase over 1912 of 55 per cent; and 1914 showed an increase over 1913 of 75 per cent. Of the 14,000,000 sq. yd. laid in 1914, about twenty-five per cent went into streets and alleyways and the remainder into country roads.

During the year 1912 our Association sent a man to visit every concrete road in the United States of which we knew, and he found out not only the reason that a road was successful, but also why some had failed. After he had traveled for seven months, we wrote a book on concrete roads, based on the information gathered during those trips. During the year 1913 we did a certain amount of road supervision, assisting engineers, contractors and civic bodies of all kinds as to proper specifications, and as to the proper class of concrete road to build to get the most lasting results. During the year 1914 we went very much farther into this special work, realizing if we were to get the greatest amount of yardage of well-built concrete roads that we would have to give assistance, not only as to specifications, but as to the

* Secretary, Association of American Portland Cement Manufacturers, Philadelphia, Pa.

actual work itself. We had about eighty men in the field. The United States was divided into seven divisions. These districts proved to be entirely too large to be covered satisfactorily. As a matter of fact, one district consists of the states of Kansas, Oklahoma, Colorado, Arizona, New Mexico, Texas, Arkansas and Louisana, a territory practically impossible for one man to cover.

Each division engineer sent into the office of the Association a daily report, a card of simple arrangement requiring little time to fill in. It noted where the man was, where he was going, the people whom he saw; and at the bottom a list of the material which he wanted from the Association office. There were a number of men during 1914 who stayed continuously on roads under construction. These we called "road assistants." The idea was for them to give assistance to every one connected with a concrete road, whether it was the foreman, the inspector on the work, the contractor, the engineer or a civic board; and incidentally to see that the contract not only was carried out, but that the work insured fairly good results. There were a number of cases where the specifications were practically abandoned after our men arrived on the work, and in other cases they were changed in such way as to insure better road construction. In one place, I remember, the city council was persuaded to make an additional allowance to the contractor for changes in the specifications, with assurance that the work, under supervision, would be successful.

The report of the road assistant is of interest. In that report we have made an effort to secure every item of interest to us. Each of those items has a certain bearing as to whether or not the concrete road is being built in such a way as to give good results. The date, the contract number and the initials of the man in the upper left-hand corner are all obvious. We must know the amount of concrete placed from station to station, in order to estimate the quantities of material which, from a theoretical standpoint, should have been used in each day's work. The proportions of the mixture also must be known for the same reason. The brand of cement was of practically no interest to us, except as a matter of curiosity. Because a company was or was not a member of our Association had absolutely nothing to do with the work which we did on concrete roads, the same assistance being given no matter what brand of cement was used. The

consistency of the concrete—dry, mushy or sloppy—showed closely how the work was being done and whether a proper surface was being obtained; the wetness of the concrete should be influenced to a great extent by the temperature—more water is needed in the hot dry weather of summer than the cooler spring and fall. This is a most important matter in concrete road building as well as in all concrete work—few of us have given sufficient attention to it. In other words, the water plays a very great part in the ultimate results to be obtained. Later strength is not so much affected, but the early strength is decidedly so and in a road which is subjected to abrasion and jarring the strength at the time the road is opened to traffic is a very important matter.

The range of temperature is interesting, to show if there was any danger of freezing, and also to show if the proper amount of water was used. The condition of the sub-base, without a doubt, is one of the most important things to be considered in the building of a road; whether it is or is not compacted uniformly so that it will give the same bearing throughout; whether it is at the right grade to permit the proper thickness of concrete; whether it has been wet, and yet contains no pools of water to prevent moisture being absorbed from the concrete. The condition of the wind is another important item, on account of the curing of the concrete itself. A warm wind blowing over a concrete road will dry out the surface too rapidly, making it chalky and of low wearing quality. A hot sun has the same effect. Proper drainage is important for all roads and more so with those of a monolithic type. Therefore, we secured information on this subject. As to the question of keeping the previous work wet and covered, we found that one of the difficulties continually encountered was that a foreman instinctively wants to keep his gang together, and dislikes having a man down the road a half mile or a mile away squirting a hose on a lot of dirt covering the concrete pavement. That was one of the most difficult things we had to contend with during the year. After the concrete had been in over night, as a rule it would bear covering with dirt, and that dirt had to be wet, and had to be kept wet, for at least ten days, and often two weeks, in order to cure the road properly. Where water was scarce it was very difficult to have the wetting done, and where a contractor had not had foresight enough to lay a pipe line so that he

would have water at all times, not only for his concrete, but also for curing, it was extremely difficult to have him delegate even one man to go along the road and keep the earth covering wet.

The number of revolutions of the drum of the mixer gives an indication of the quality of the concrete. How many engineers, inspectors and contractors know the proper number of revolutions required in order to obtain a thoroughly mixed batch? And yet, if all the ingredients are not brought into contact one with the other, the desired results are not obtained. In order to ascertain whether the material was well mixed, we noted the revolutions of the mixer four times each day. As to the details of construction, the joints are very important, about which I shall have something to say later. They are the most difficult part of concrete road construction, and will probably bear as much additional light as any other point. The side forms are important for the reason that if they are of wood, and not capped with some kind of metal edging, they are likely to sag, due to the weight of the template being brought on them, and also due to the fact that they naturally absorb a certain amount of water from the concrete. When they do sag, they will cause a wavy road, high at the joints and low between them, making it disagreeable to ride over.

The surface finish is another important item, we wished to know if it should be rough or smooth, broomed or finished with a wooden float, as each of these causes a different texture, and gives a varying wearing quality to the road itself. The thickness of the pavement, naturally, must be known in order to estimate the amounts of material required. The back of the report previously mentioned was used for any remarks which the inspector might have to make, relative to the road work itself. Every day from these reports there was figured the amount of cement which should have been used, and we depended to a great extent on the comparison between this amount and the amount actually used for determining whether or not the contractor was getting a proper mixture. We found quite frequently that a contractor would forget on some days, or at least his foreman would forget, to put in cement; and we have found anywhere from one or two per cent to thirty per cent loss. Naturally, when we found a loss of as much as thirty per cent that should have gone into the

mixture, there was investigation made and the deficit was remedied. To a small loss we paid no attention. We often found that losing cement out of the mixture on a concrete road was more a matter of carelessness than direct intent of the contractor to skin the job, because we ran into many cases where the contractor would put possibly ten per cent more cement into his mixture than was required by our theoretical figures.

When all of this material is gathered, we check it and compile the information on a single sheet, which is the finale of our road reports. We are not sure, of course, but we think we have a sheet of this kind for nearly every road which has been built of concrete in the United States, including those which have a carpet coat of bitumen and sand on top.

We were received so kindly, and so many of the engineers whom we assisted last year are so anxious to have our co-operation this year, that we found it necessary to divide the United States into sixteen districts. In each district we are placing a division engineer, who will control, from our point of view, all of the activities in concrete construction in that section. He will not only be able to assist in road construction, but also in any other class of concrete work. Naturally, there will be recurring questions which are bound to arise, about which he has not intimate knowledge, and these will be referred to the office of the Association.

Many salient features were developed in road construction during the year. First, we need to know more about the materials which go to make up the concrete—in other words, the aggregates. We should know more about the sand and stone; and it is necessary to form some standard in the nature of a physical analysis which can be made in the field, and which will to a great extent determine the lack of fine material in the sand itself, and the amount of loam or clay present; and this determination should be made, in a rough way at least, for both the fine and coarse aggregate. The second matter which has been brought to our attention relates to the use of metal protection plates. We believe that the use of such plates has its limitations, chiefly on account of the difficulty in properly setting them in place, and because at least fifty per cent of the metal protection plates which are put in concrete are not set exactly from one end to the other

to the true grade of the concrete itself. We find that they are either high or low. If they are low, they might as well be left out, because iron-shod traffic going over them crushes down the edges, and it requires exactly the same maintenance to keep up a metal protected joint as it does one not thus protected. If high they are a menace to traffic. In putting in a joint we believe that particular care should be taken to secure the utmost density of the concrete immediately next to the joint itself. This can be effected by spading at both sides of the joint and by the use of a steel float on the surface for three or four inches either side of the joint.

In order to obtain a uniformly level surface on either side of a prepared filler joint, a split float should be used which allows the filler, protruding above the finished surface of the road, to pass between the two sides of the float. The filler is allowed to remain in the joint and extend above it until after the concrete has hardened, when, if necessary, it can be cut down with a shovel or knife to within about a half inch of the surface of the roadway; and may then be ironed down between the beveled or rounded edges or can be left to be rolled down by the traffic itself. Before I leave this joint proposition, I want to say that there is a question as to the advisability and practicability of installing joints at all. If we do not use artificial joints we must realize that the concrete is bound to crack in irregular lines and that these cracks must be protected against wear. The joints must be made perpendicular to the surface of the road. This is very important. If it is not done, when expansion takes place in the road, as it surely will, one section will slide up on an inclined joint. I have seen roads that slid so far that one section went clear above the other section, and passed the end, and when it contracted did not go back into place. The reason for it was simply because the joint, instead of being perpendicular, was made on an angle.

Without doubt, all roads over 20 ft. in width should be reinforced, and also roads of lesser width where there are poor drainage conditions, or where the sub-base, on account of its nature, cannot be well compacted. In any case, reinforcement provides an additional factor of safety.

There has been some talk lately as to the use of hydrated

lime in concrete roads. We are not yet ready to say whether or not it is beneficial, because we do not know enough about it to even venture an opinion. There are experiments under way at the present time which are being carefully watched, and of course, if they show that it improves a road, or betters it so far as traffic is concerned, and makes the concrete easier to work, we will advocate the use of hydrated lime. If, on the other hand, it proves to be of no advantage, we will not advocate its use. We believe that every concrete road job should have canvas included in the equipment at least sufficient to cover a few sections, in case of a very hot day, very dry or high wind, or in case of rain. Another feature often neglected is to keep the temperature of the aggregates as low as possible. Hot stone, sand or water mixed in concrete produce a quick set; and at times so quick that the concrete sets before it is placed on the road. When this happens hair cracks form in the surface of the road which are liable to prove detrimental.

The use of a heavy template is advocated. We have been using templates of two-inch plank, shod with iron, but we believe a heavier template, although a little more difficult to work, produces a more even surface, and assists not only in bringing the surface to a true grade, but also in actually compacting and obtaining a denser concrete. There has been a distinct tendency to increase the thickness of concrete roads; and while we venture to say that we were generally satisfied with a thickness of five inches at the side and seven inches in the middle, today we are figuring on six and eight inches respectively, believing that the additional cost of material—and that is practically all the additional cost—is well invested. I cannot help but note the passing of the bituminous top. In 1909 a large percentage of the roads that were built of concrete had a top of bitumen and sand. Today a very small percentage have this surface treatment; and the reason for it is that the people in general have become accustomed to a concrete surface, and inasmuch as it fulfills all the requirements of traffic, they do not consider that the additional expense of using bitumen and sand is warranted.

In closing, I wish to say that there are certain phases of concrete road construction about which we would like more exact information; and we would like to see further experiments

made by those of you interested in concrete road construction. Concrete roads are subject to change due to varying temperature and moisture, and cracks occur. We would like to know the frictional relation between the sub-base and the concrete slab. We would like to know more exactly the varying conditions of heat and moisture under which they move, so that we may arrive at some method to minimize that movement and avoid the cracks as much as possible—not that cracks are injurious to the concrete road, but each crack increases by just that much the cost of maintenance. We would like to know a more accurate method for determining the spacing of joints. Today we say joints should be spaced not over thirty-five feet apart. The reason for this is because we are conservative, and allow perhaps a larger factor of safety than is necessary. Although there are a few instances of sections of concrete roads with joints spaced one hundred feet apart which have not cracked between the joints, we know of other places where no joints have been placed and the roads have cracked, the distance between cracks varying from about twenty to a hundred feet. If we can put joints fifty feet apart with any degree of safety, we are that much better off. We would like to know the amount of reinforcement necessary to put in a concrete road. Today we are guessing at it. We are putting in the amount of reinforcing which we think is safe, but we do not know, from a theoretical standpoint, how much or how little reinforcing is required. We would like to know of a simple field test to determine the abrasive quality of the stone; we all realize that in a concrete road, and every class of macadam road, the stone itself has to take the wear; and naturally its abrasive quality is of great importance. Highway officials can send stone to Washington and have its abrasive qualities determined, but we do not know of any test which will show us how to determine this in the field.

Gentlemen, I think I have covered the subject of 1914 concrete road construction, although perhaps not very thoroughly. If any of you have any questions to ask, and I can answer them, I shall be very glad to do so.

DISCUSSION.

Mr. Whited. MR. WILLIS WHITED.—I would like to ask the best way to repair a concrete road when it gets worn. Last winter I was down in Washington and I saw a section of road near the Potomac River that had been laid several years. It had cracked in several places, and had begun to wear down at the joints; and they were tearing it up, including the brick gutters. Now, is it practicable to repair such roads with a cement gun, or is there any other method which is better which will save tearing up the pavement whenever it shows signs of wear?

Mr. Wilson. MR. PERCY H. WILSON.—The road in Washington to which Mr. Whited refers is a Blome pavement, and approaches the long bridge that goes across the Potomac flats. It is built on a fill made by a hydraulic dredge. The fill consists of soft mud, making a poor foundation which will settle for many years to come. Unfortunately, however, it does not settle evenly, and when it has settled it has cracked the concrete pavement just the same as it would any other pavement which might be in that particular place. I do not think the road could ever be properly repaired, because it would be a matter of taking the foundation out and filling in with some kind of material which would not continue to settle. It might have been better if the pavement had been reinforced, because that would have a tendency to hold the concrete together. No effort, as far as I know, was ever made to repair the cracks. They were never filled with tar; nothing ever was done. Turning to the matter of repairs, it depends a great deal upon what Mr. Whited means by "signs of wear." If he means that the road is wearing at the cracks in the shape of a V, it may be repaired with tar and sand, a very easy proposition; which, owing somewhat to the amount of traffic, could be renewed every two or three years; but it must be kept up. If he means that in individual sections wood has been allowed to stay in the surface of the road, and eventually has worked out, leaving a hole which chips under iron-shod traffic, tar and sand again will do it. If he means that in some

parts of the road the man who has charge of the cement has forgotten to put any cement in one or two batches, and it consists of sand and stone, it can be very readily cut out and replaced with new concrete. The edges should be cut square and after the new concrete has dried out the edges should be covered with tar and sand, just the same as the joint in a concrete road. Mr. Wilson.

MR. WHITED.—The reason for my question was to confirm an idea I have with reference to finishing bridge floors with plain concrete, without asphalt or other protection; my idea is to add possibly an inch or two of concrete to the surface, to take the wear; and when it wears so badly that is must be repaired, instead of tearing the whole bridge down, it may be repaired with the cement gun; or perhaps you know some better way to do it. Mr. Whited.

MR. WILSON.—I would suggest repairing by chipping out in squares if any holes form and replacing with fresh concrete, rather than by using a cement gun or anything of that kind. I would like to ask if this two-inch finish is to be put on at the time the bridge is cast? Mr. Wilson.

MR. WHITED.—Oh, yes, certainly, just simply add that much to the thickness of the slab. Mr. Whited.

MR. WILSON.—What mixture do you use in the slabs, 1: 2: 4? Mr. Wilson.

MR. WHITED.—Generally, yes sir. We can put a richer surface on if it is necessary. Mr. Whited.

MR. WILSON.—If you are going to put on a richer surface and put it on at the same time as the bridge itself, it is going to be a little bit difficult to get your inch and a half layer of concrete to stick, unless the two are cast together. Mr. Wilson.

MR. WHITED.—If the coating is placed before the other begins to set it will be all right. Mr. Whited.

MR. WILSON.—The coating should be put on before the base begins to harden, even before it gets its initial set. It should be put on within thirty minutes of the placing of the base, otherwise there may be no bond. Mr. Wilson.

MR. W. W. WHEELER.—I would like to ask a question relative to the sub-grade. Where we are laying the concrete road on the clay sub-grade in wet water, it is very hard to get a smooth sub-grade. It has been the practice in some places to put a sand covering over this clay sub-base in order to get Mr. Wheeler.

Mr. Wheeler. a smooth surface. I want to know whether there is any data as to whether this is a good practice or bad practice.

Mr. Wilson. MR. WILSON.—As a matter of fact, can you roll a clay sub-base that is wet without putting sand on it?

Mr. Wheeler. MR. WHEELER.—Not very well. But if it is bad practice to put sand on top, you had better wait until it is dry.

Mr. Wilson. MR. WILSON.—I know of no objections to the use of sand over a wet clay sub-base; it is without a doubt advantageous.

Mr. Hubbell. MR. C. H. HUBBELL.—With reference to the prior question, I have had some experience which in a way answers the gentleman's questions. My experience in the last four years with that kind of work has shown that my roads show no disintegration, no mending of the extra inch and a half or two-inch coat, for the simple reason that the top is put on immediately after the base is laid. I have one of those pouring mixers, and the joints are spaced 25 to 30 apart; and an immediate application of that second course prevents it from disintegrating. I would like to ask Mr. Wilson how can he explain why alley concrete, where there is a dish in the center, will not crack, and some streets will crack? Is it because of the crowns that they crack, or of the dish in the alleys that they do not crack, or because of the headers on the sides?

Mr. Wilson. MR. WILSON.—That last question is very hard to answer, because there are so many things that enter into the cracking of the concrete pavement; and I am very frank to say that I do not know all of the reasons why a concrete pavement cracks. Do the alleys of which you speak being dished, have curbs at the extreme outer edges?

Mr. Hubbell. MR. HUBBELL.—No, fences.

Mr. Wilson. MR. WILSON.—The shape undoubtedly has something to do with the cracking. When the slab contracts it has a better opportunity to move where the sub-base is dished than where it is crowned.

Mr. Mueller. MR. JOHN W. MUELLER.—Mr. President, I might add to Mr. Wilson's explanation that in the dished alley the section is in compression, where the crown has a good deal of tension Most of the movements or stresses of the dished section are in compression.

MR. E. S. MACGOWAN.—I would like to ask Mr. Wilson the present attitude which they take relative to brooming the surface of concrete roads or pavement. Mr. MacGowan.

MR. WILSON.—We think there is no necessity for brooming and the only reason in some cases where we have suggested brooming is because you will find some people who say that a concrete pavement is bound to be slippery, and the only way you can prove that it can be made so as not to be slippery to people who have had no experience is to give them a broom and say, "You can make it as rough as you please." Mr. Wilson.

DESCRIPTION OF THE OXFORD PIKE SERVICE TEST CONCRETE ROADWAY, PHILADELPHIA.

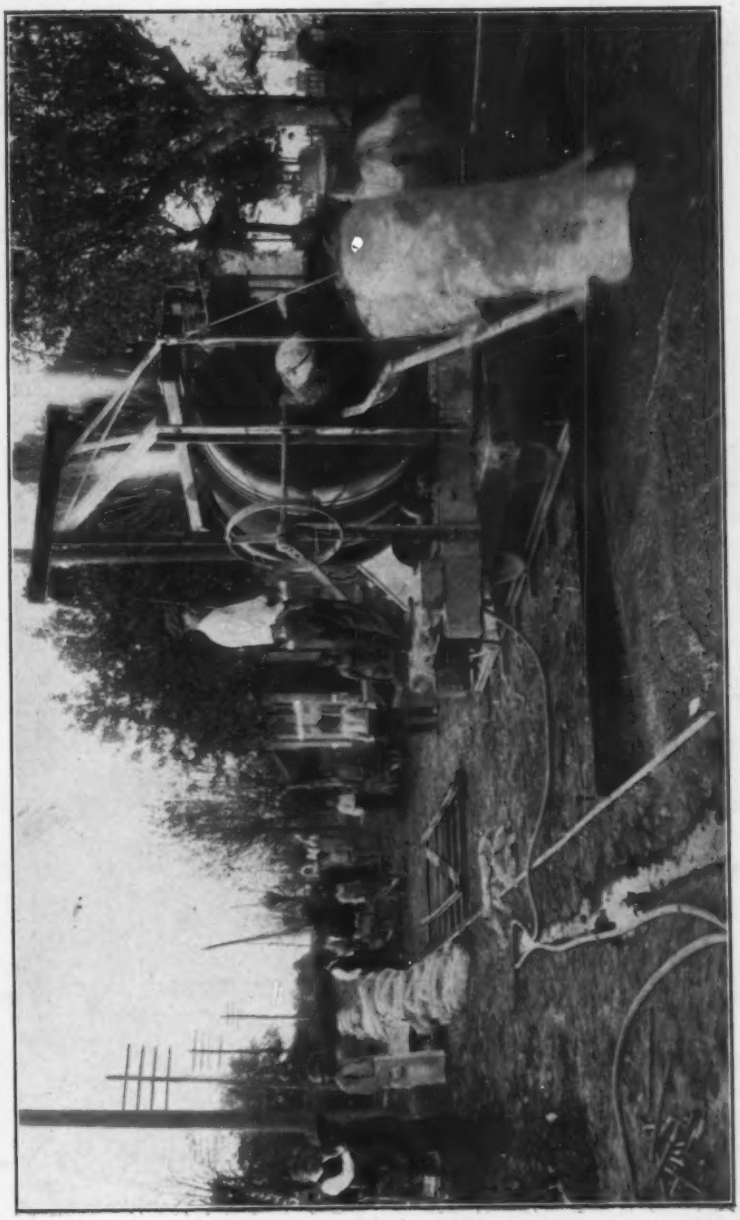
By William H. Connell.*

With the object of assisting in the research work being carried on throughout the country toward perfecting a concrete pavement, principally for country roads, both with and without bituminous surface treatment, specifications were drawn for the construction of a roadway to be known as the "Oxford Pike Service Test Concrete Roadway of Philadelphia." These specifications were compiled after consultation with the Association of American Portland Cement Manufacturers and with engineers who have made a study of concrete and are experts on this subject, and comprise the latest methods of construction for roadways of this type to be laid under the conditions existing where this pavement is being constructed.

There were two purposes considered when the construction of this roadway was contemplated, one was to endeavor to construct a concrete road that would give good service where the traffic came directly upon the concrete surface, and the other was to try out certain types of bituminous surfaces on the different characters of concrete construction embodied in the various sections of this roadway, with a view to finding some such material that could be applied with a thickness of not over one-quarter of an inch that would adhere to the concrete and not peel off, as has been the case with practically all of these film coat bituminous surface treatments.

The work, which was started October 4, 1914, is being done on that portion of the Oxford Road between the Northeast Boulevard and Rising Sun Avenue. The experimental sections, having a total length of a little over two miles, consist of five main sections, each differing in the character of the concrete, and each of which will be sub-divided into several sub-sections according to the character of the surface.

*Chief, Bureau of Highway and Street Cleaning, Philadelphia, Pa.



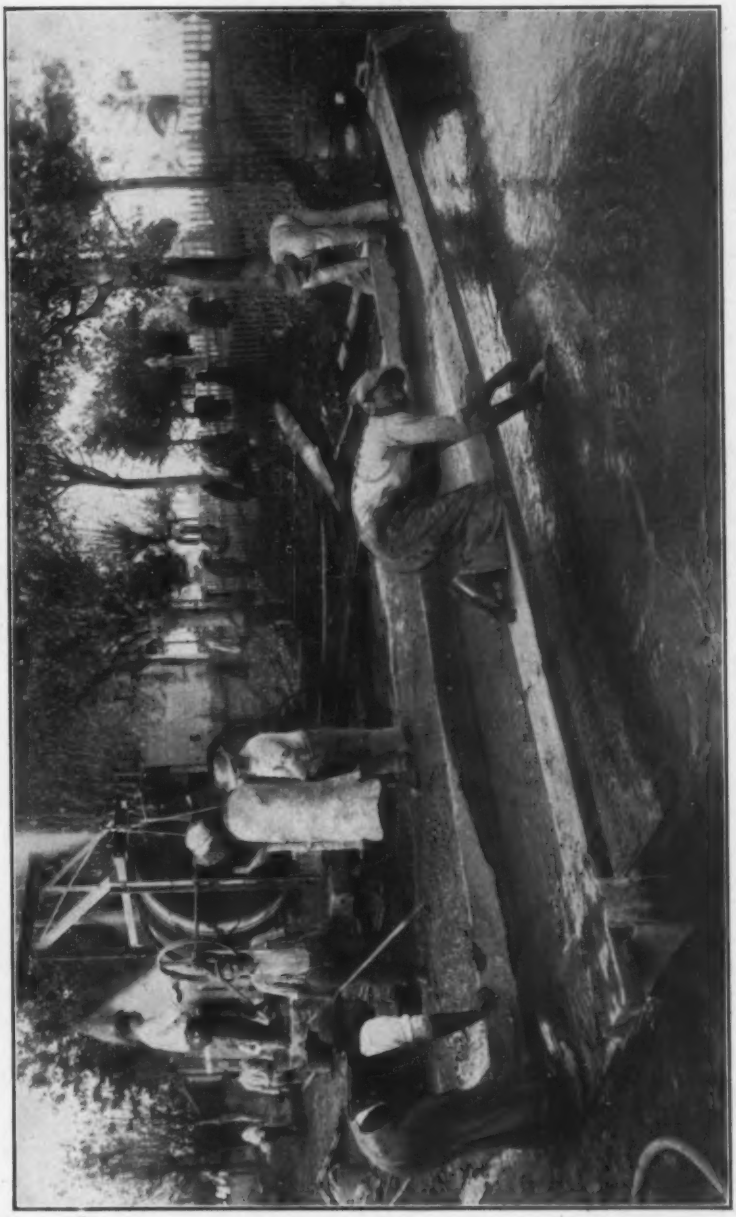
OXFORD PIKE. SERVICE TEST ROAD. CONCRETE PAVEMENT. SHOWING SUB-GRADE CONDITIONS, CONSTRUCTION OF FORMS AND METHOD OF PLACING CONCRETE.

Each section of concrete will be 2,250 ft. long and divided into two sub-sections, one 1,050 ft. in length and the other 1,200 ft. The 1,050-ft. section will have no bituminous wearing surface and will have eighteen bituminous expansion joints and seventeen steel protected joints. The 1,200-ft. section will be divided into four parts, 300 ft. long, on each of which a different surface treatment will be applied. The first wearing surface will be a refined coal gas tar; the second, a refined water gas tar; the third, an asphalt cut-back; and the fourth, rock asphalt and chips; bituminous expansion joints being used in each case. The expansion joints are 30 ft. apart and it is specified that they shall not exceed three-eights of an inch.

In the preparation of the sub-grade, the old macadam roadway is removed to a sufficient depth, shaped up, and thoroughly compacted to a flat sub-grade with a steam roller weighing not less than ten tons. The concrete is then laid to a depth of 5 in. at the sides, $7\frac{1}{4}$ in. in the center and $6\frac{1}{2}$ in. at the quarter points, the width of the road being 18 ft. On the portions of the sections which are to be covered with bituminous material, the surface is left one-quarter of an inch below the grade of the completed pavement and parallel thereto. The concrete is composed of one part Portland cement and five parts of coarse and fine aggregate, mixed so as to produce a composition of the maximum density and strength, the proportions being determined by volume, considering a barrel of Portland cement equal to 3.8 cu. ft.

The concrete is mixed in batch mixers, the mixing being continued for at least one and one-half minutes after the materials are in the drum. The surface is struck off with a templet and finished with a wood float operated from a bridge. The specifications provide that the finished surface shall not vary more than one-quarter of an inch from the established cross section. No traffic is to be permitted on the concrete for at least a month after it is finished, the pavement being protected during that time by a layer of sand or earth, about one inch thick, and during the first week after the completion of the pavement it is to be wet at least three times daily.

After starting this work considerable difficulty was encountered in obtaining stone grit which would comply with the requirements of the specifications. The requirement for the trap rock



OXFORD PIKE. SERVICE TEST ROAD. CONCRETE PAVEMENT. SHOWING PLACING, STRIKING-OFF, AND FLOATING OF CONCRETE.

grit states that all of it shall pass a one-quarter inch screen, not more than five per cent shall pass a 100-mesh sieve, and not more than fifteen per cent of it shall pass a 50-mesh sieve. It also requires that the strength of this grit shall equal the strength of Ottawa sand when mixed in briquettes of one part cement and three parts aggregate. After the work was begun it was found that material conforming exactly to this specification could not be procured in the open market, and it was consequently decided to accept materials and combination of materials conforming as closely as possible to the requirements for grading of sizes, provided it met the tests for strength.

On section three, trap rock screenings were furnished to be used with an equal part of Jersey gravel. These screenings contain from eight to ten per cent of material retained on a one-quarter inch screen, and twenty-five to thirty per cent of material passing a 50-mesh sieve (including fifteen to eighteen per cent passing a 100-mesh sieve), thus having an excess of both coarse and fine material. This was consequently combined with clean trap rock chips from the same source, in the proportion of two parts screenings to one part clean grit, the latter consisting of material, eighty-five per cent of which passed a one-quarter inch screen, and all of it retained on a No. 50 sieve.

The combined grading of these three materials follows:

2 parts Lambertville screenings,
1 part Lambertville grit,
Combined with an equal amount of Jersey gravel.

Passing 200 mesh sieve				3.1	per cent
"	100	"	"	4.6	"
"	50	"	"	16.1	"
"	40	"	"	11.8	"
"	10	"	"	36.4	"
"	10	"	"	36.4	"
"	¼ inch screen			22.5	"
Retained on ¼ inch screen				5.5	"
				100.0	

On Sections 4 and 5, where the specifications require one part cement, two parts of trap rock grit, and three parts crushed limestone or trap, respectively, trap rock screenings from the

OXFORD PIKE. SERVICE TEST ROAD. CONCRETE PAVEMENT. COMPLETED PAVEMENT COVERED WITH EARTH IN FOREGROUND.

Pennington Trap Rock Company, were furnished. This material contains from fifteen to thirty per cent of sizes retained on a one-quarter inch screen, and from seventeen to twenty-three per cent of material passing a No. 50 sieve (including ten to fourteen per cent of material passing a No. 100 sieve), thus having an excess of coarse sizes and a slight excess of fine material. In the use of these screenings, the largest of the oversized material has been counted in the coarse aggregate in order not to reduce the amount of fine aggregate required for mortar. Briquettes made from that portion of these screenings passing a one-quarter inch screen have shown a strength exceeding that of Ottawa sand, thus meeting the specified requirements. Seven thousand four hundred and fifty (7450) ft., or about two-thirds of the roadway, was completed last fall and the remainder will be completed this spring. Thus far during the winter, longitudinal cracks have appeared on 17 of the 30-ft. sections between the contraction or expansion joints, but no opinions will be expressed at this time as to the causes of these cracks. It should be borne in mind, however, that this concrete roadway was built on a macadam road about thirty years old, where the drainage conditions were consequently better than ordinarily could be expected, and that the greatest care has been taken both in the construction and the inspection of the materials.

Accurate cost data and other pertinent information will be compiled in connection with this work and published after the road is completed.

The following are complete specifications for the whole work:

SPECIFICATIONS FOR CONCRETE ROADWAY ON OXFORD PIKE FROM THE BOULEVARD TO RISING SUN AVENUE.

1. *Description.*—The pavement shall consist of Portland cement concrete $7\frac{1}{4}$ in. thick in the middle, $6\frac{1}{2}$ in. thick at the quarter points and 5 in. thick at the sides, on portions of which a second course of $\frac{1}{4}$-in. bituminous wearing surface shall be laid.

2. *Preparation of Sub-grade.*—The present macadam roadway and macadam base shall be removed to a sufficient depth to conform to the grade and cross section 5 to $7\frac{1}{4}$ in. below the

finished pavement. All interstices in the surface of the macadam so prepared shall be filled with fine material and rolled to make a smooth tight surface of the roadbed.

PORTLAND CEMENT CONCRETE BASE.

3. *Thickness.*—After the sub-grade has been properly prepared and thoroughly compacted with a steam roller weighing not less than 10 tons, until the new surface shall be exactly the required depth below the finished grade of the pavement there shall be laid a concrete base or foundation 5 in. in thickness at the sides, $7\frac{1}{4}$ in. thick in the center and $6\frac{1}{2}$ in. thick at the quarter points, the concrete conforming to these specifications. The finished surface of the concrete base shall be $\frac{1}{4}$ in. below the finished grade of the pavement and parallel thereto.

4. *Composition.*—Concrete shall be composed of 1 part cement and 5 parts coarse and fine aggregate, so mixed as to produce a composition of the greatest density and strength. The proportions shall be determined by volume measurement, a barrel of Portland cement being considered to contain 3.8 cu. ft.

The composition from Station 0 to Station 22+50 shall be generally 1 part cement, 2 parts sand and 3 parts gravel.

From Station 22+50 to Station 45 the composition shall be generally 1 part cement, 2 parts sand and 3 parts crushed trap rock.

From Station 45 to Station 67+50 the composition shall be generally 1 part cement, 1 part stone grit, 1 part sand and 3 parts crushed trap rock.

From Station 67+50 to Station 90 the composition shall be generally 1 part cement, 2 parts trap rock grit and 3 parts crushed hard limestone with coefficient of wear of 10 or over.

From Station 90 to Station 112+50 the composition shall be generally 1 part cement, 2 parts stone grit and 3 parts crushed trap rock.

The quantity of water shall be such as in the opinion of the Chief of the Bureau shall be necessary to produce a concrete which when deposited will settle to a flattened mass, but shall not be so wet as to cause a separation of the mortar from the coarse aggregate in handling.

5. *Stone Grit.*—The stone grit shall consist of screenings from clean, hard crushed trap rock and graded from fine to coarse, with the coarse particles predominating and passing when dry a screen having ¼-in. openings. It shall be clean, hard, free from dust, loam, vegetable or other deleterious matter. Not more than 15 per cent shall pass a sieve having 50 meshes per lin. in. and not more than 5 per cent shall pass a sieve having 100 meshes per lin. in. The strength of the stone grit when mixed in briquettes of 1 part cement and 3 parts grit shall be not less than the tensile strength of similar briquettes mixed with 1 part cement and 3 parts Ottawa sand.

6. *Sand.*—The sand shall be graded from coarse to fine, not exceeding ¼ in. in diameter. It shall contain not more than 5 per cent of material removed by the elutriation test, and shall be equal to the best New Jersey bank sand or gravel. The strength of the sand when mixed in briquettes of 1 part Portland Cement and 3 parts sand shall not be less than the tensile strength of similar briquettes mixed with 1 part cement and 3 parts Ottawa sand.

7. *Crushed Stone.*—The stone shall be an approved clean, hard, cubical crushed limestone with coefficient of wear of not less than 10, or trap rock with coefficient of wear of not less than 15, or gravel. It shall pass a 1½-in. ring and shall be retained on a ¼-in. screen and be uniformly graded. Care shall be taken that the stone or gravel as used is mixed as to size.

8. *Water.*—Water shall be clean, free from oil, acid, alkali, or vegetable matter.

9. *Mixing Conditions.*—Concrete shall not be mixed in larger quantities than is required for immediate use, and any that has developed initial set or has been mixed for 30 minutes shall not be retempered or used in any way. The ingredients shall be free from refuse. Stone shall be handled with forks, the tines of which shall be so spaced that the smallest size of the stone will not pass through them.

10. *Machine Mixing.*—The mixing of concrete shall be done by machinery and the materials shall be so mixed as to insure a uniform product of the specified proportions of all the ingredients. The machine shall be a batch mixer of an approved type. Continuous mixing machines shall not be used. The

mixing shall continue for at least 1½ minutes after the materials are in the drum and in the mixing period the drum shall make at least 14 revolutions. The contractor will be required to keep not less than two mixing machines in operation on this work.

FORMS.

11. *Materials.*—The forms shall be free from warp, of sufficient strength to resist springing out of shape, and shall be equal in width to the thickness of the pavement at the edges. Wooden forms shall be of not less than 2-in. stock, and shall be capped with 2-in. angle iron.

12. *Setting.*—The forms shall be well staked or otherwise held to the established line and grades, and the upper edges shall conform to the established grade of the road.

13. *Treatment.*—All mortar and dirt shall be removed from the forms that have previously been used.

PLACING CONCRETE.

14. *Placing.*—Immediately prior to placing the concrete, the sub-grade shall be brought to an even surface. The surface of the sub-grade shall be thoroughly wet when the concrete is placed.

After mixing, the concrete shall be deposited rapidly in successive batches upon the sub-grade prepared as hereinbefore specified. The concrete shall be deposited to the required depth and for the entire width of the pavement, in a continuous operation, between transverse joints without the use of intermediate forms or bulkheads.

In case of a breakdown concrete shall be mixed by hand to complete the section or an intermediate transverse joint placed as hereinbefore specified at the point of stopping work. Any concrete in excess of that needed to complete a section at the stopping of work shall not be used in the work.

15. *Finishing.*—The surface of the concrete shall be struck off by means of a templet or strike board which shall be moved with a combined longitudinal and cross-wise motion. When the strike board is within 3 ft. of a transverse joint it shall be lifted to the joint and the pavement struck by moving the strike board

away from the joint; any excess concrete shall be removed. Concrete adjoining the metal protection plates at transverse joints shall be dense in character, and any holes left by removing any device used in installing the metal protection plates shall be immediately filled with concrete.

After being brought to the established grade with the templet or strike board, the concrete shall be finished from a suitable bridge, no part of which shall come in contact with the concrete. The concrete shall be finished with a wood float in a manner to thoroughly compact it and produce a surface free from depressions or inequalities of any kind. The finished surface of the pavement shall not vary more than $\frac{1}{4}$ in. from the true shape. The floating shall be done from a movable bridge built to span the concrete and from which the men may work without resting upon the surface of the work.

16. *Protection.*—After the concrete is completed it shall be covered with a layer of sand or clean earth which shall remain on the concrete for a period of not less than one month. During the first week after the concrete has been laid the surface of the concrete shall be thoroughly wetted not less than three times a day. No traffic of any sort shall be permitted on the concrete until the earth or sand has been removed and the contractor will be responsible for any damage that may be done by permitting traffic to so enter upon the work.

17. Each section of concrete, 2,250 ft. in length, shall be divided into two lengths of 1,050 and 1,200 ft. respectively.

The 1,050-ft. length will have no bituminous wearing surface and will have 18 bituminous expansion joints and 17 steel protected joints. The 1,200-ft. length of each concrete section shall be divided into four different portions, each 300 ft. in length, as follows:

The first section of 300 ft. will be laid with a Tarvia wearing surface and will have bituminous expansion joints.

The second section of 300 ft. will be laid with a Ugite wearing surface with bituminous expansion joints.

The third section of 300 ft. will be laid with an asphalt cut-back wearing surface with bituminous expansion joints.

The fourth section of 300 ft. will be laid with a Unionite wearing surface with bituminous expansion joints.

The 1,200-ft. portions of adjoining sections of concrete shall be so arranged that there will be in the finished road two sections 2,400 ft. in length and one section 1,200 ft. in length, on each of which there will be a continuous stretch of bituminous wearing surface.

18. *Steel Protected Joints.*—Transverse joints shall not be less than $\frac{1}{4}$ in. nor more than $\frac{3}{8}$ in. in width and shall be placed across the pavement perpendicular to the center line, not more than 30 ft. apart. All joints shall extend through the entire thickness of the pavement and shall be perpendicular to its surface.

The concrete at transverse joints shall be protected with soft steel joint protection plates which shall be not less than $2\frac{1}{2}$ in. in depth and not less than $\frac{1}{8}$ in. or more than $\frac{1}{4}$ in. average thickness. The plates shall be of such form as to provide for rigid anchorage to the concrete. The type and method of installation of joint protection plates shall be approved by the engineer. The surface edges of the metal plates shall conform to the finished surface of the concrete.

All joint protection plates over $\frac{1}{4}$ in. high or $\frac{1}{2}$ in. low shall be removed.

Joint Filler.—All joints shall be formed by inserting during construction and leaving in place the required thickness of prepared felt or similar material of approved quality, having a thickness of not less than $\frac{1}{8}$-in. nor more than $\frac{1}{4}$ in., which shall extend through the entire thickness of the pavement.

19. *Bituminous Expansion Joints.*—Bituminous expansion joints shall be placed across the pavement perpendicular to the center line spaced not more than 30 ft. apart, and shall be formed by inserting during construction and leaving in place an approved tar or asphalt prepared joint filler having a thickness of not less than $\frac{1}{8}$ in. nor more than $\frac{1}{4}$ in., which shall extend through the entire thickness of the pavement.

BITUMINOUS WEARING SURFACES.

20. *Tarvia.*—Upon the thoroughly cleaned concrete shall be placed with a pressure distributor a bituminous priming coat of Tarvia B of $\frac{1}{5}$ of a gallon per square yard. After the priming coat has thoroughly dried into the concrete there shall be applied

with a pressure distributor a first coat of Tarvia A of $\frac{1}{4}$ of a gallon to the square yard. After the first coat has been applied there shall be spread a layer of clean, hard trap rock chips with a coefficient of wear of not less than 15 and which will pass a $\frac{1}{2}$-in. screen and be retained on a No. 10 screen. Only sufficient chips will be used to prevent the distributing machine from sticking to the first coat.

As soon after the application of the first coat as the Chief of the Bureau shall determine, there shall be applied with a pressure distributor a second coat of Tarvia A of $\frac{1}{4}$ of a gallon to the square yard, and upon this second coat there shall be spread a thin layer of clean trap rock chips with a coefficient of wear of not less than 15 and which will pass a $\frac{1}{2}$-in. screen and be retained on a No. 10 screen.

SPECIFICATION FOR TARVIA B.

The specific gravity shall not be less than 1.14 nor more than 1.18 at 60° F.

The viscosity tested by the standard Engler viscosimeter shall not be more than 100 seconds for 100 c.c. at 140° F.

On distilling one hundred grams of the material at 500° F., the residue shall not be less than 70 grams. This residue shall be a soft pitch at 60° F. If the residue appears hard, it shall be tested for melting point and the melting point shall not exceed 140° F. by the $\frac{1}{2}$-in. cube method.

The free carbon shall not be less than 4 per cent.

In making the foregoing tests, the following methods shall be employed:

SPECIFIC GRAVITY.

The specific gravity shall be determined by the use of a Hubbard type specific gravity bottle. The bottle shall be filled with the liquid material at a convenient temperature. The bottle shall then be kept in a water bath at 60° F. until the level of the liquid, after adjustment to the mark, shows no further contraction. The bottle shall then be weighed. The weight of the material, divided by the weight of the same volume of freshly boiled distilled water at 60° F., is the specific gravity.

DISTILLATION.

One hundred grams of the material shall be distilled in an eight-ounce glass retort according to the standard method for distilling creosote oil, as described in Bulletin No. 65 of the American Railway Engineering and Maintenance of Way Association. The retort shall be weighed and exactly 100 grams of the material weighed in the retort shall be used. The thermometer shall be inserted in the retort with the lower end of the bulb $\frac{1}{2}$ in. above the surface of the material, and the condensing tube shall be attached to the retort by a tight cork joint. The distance between the bulb of the thermometer and the end of the condensing tube shall be not less than 20 nor more than 24 in., and during the progress of the distillation the thermometer shall remain in the position originally placed.

The distillate shall be collected in weighed flasks and fractions shall be determined by weight.

Receivers shall be changed when the thermometer records a temperature of 338° F. When the thermometer records a temperature of 500° F., the flame shall be removed. The distillation shall be continuous and the oil shall come over at a rate of one to two drops per second.

MELTING POINT.

A clean shaped $\frac{1}{2}$-in. cube of the material shall be formed in the mold, placed on a hook of No. 12 (B. & S. gage) copper wire, and suspended in a 600 c.c. beaker so that the bottom of the cube shall be 1 in. above the bottom of the beaker (a sheet of paper placed on the bottom of the beaker and conveniently weighted will prevent the pitch from sticking to the beaker when it drops off). The cube shall remain five minutes in 400 c.c. of freshly distilled water kept at a temperature of 40° F. before heat is applied. Heat shall be applied in such manner that the temperature of the water shall be raised 9° F. each minute. The temperature recorded by the thermometer at the instant the material touches the bottom of the beaker shall be the melting point.

FREE CARBON.

The free carbon shall be determined by making a hot extraction of five to ten grams of material with c. p. toluol followed

by c. p. benzol, or c. p. benzol, followed by chloroform as solvents. The extraction shall be made in a Soxhlet, Knorr, Underwriters, or some other suitable extraction apparatus. The distillation of the solvent shall be continued until the washings run through practically colorless.

VISCOSITY.

The viscosity shall be determined in a standard Engler viscosimeter at 140° F. Sufficient material shall be placed in the viscosimeter to bring the surface of the liquid to a level with the tops of the three leveling points. The time required to discharge 100 c.c. shall be recorded as the viscosity.

SPECIFICATION FOR TARVIA A.

The specific gravity shall be not less than 1.19 at 60° F.

The viscosity tested by the standard Engler viscosimeter, shall be not less than 125 seconds nor more than 200 seconds for 100 c.c. at 212° F.

On distilling 100 grams of the material, no distillate shall come over below 338° F. The distillation shall be continued to 600° F. The specific gravity of the entire distillate shall not be less than 1.03 at 60° F. The residue from the foregoing distillation shall have a melting point not greater than 165° F.

The free carbon shall be not less than 10 per cent nor more than 25 per cent.

In making the foregoing tests, the following methods shall be used:

SPECIFIC GRAVITY.

The specific gravity shall be determined by the use of a Hubbard type specific gravity bottle. Approximately ten grams of melted material shall be placed in the weighing bottle and the weight taken after cooling. Freshly boiled distilled water shall be added and the bottle kept in a bath at 60° F. until no further contraction takes place. The water shall then be adjusted to the mark and the bottle removed from the bath and weighed. The weight of the material divided by the weight of the water displaced is the specific gravity.

DISTILLATION.

One hundred grams of the material shall be distilled in an eight-ounce glass retort, according to the standard method for distilling creosote oil, as described in Bulletin No. 65 of the American Railway Engineering and Maintenance of Way Association. The retort shall be weighed, and exactly one hundred grams of the material weighed in the retort shall be used. The thermometer shall be inserted in the retort with the lower end of the bulb ½ in. above the surface of the material, and the condensing tube shall be attached to the retort by a tight cork joint. The distance between the bulb of the thermometer and the end of the condensing tube shall be not less than 20 nor more than 24 in., and during the progress of the distillation the thermometer shall remain in the position originally placed.

The distillate shall be collected in weighed flasks, and fractions shall be determined by weight.

Receivers shall be changed when the thermometer records a temperature of 338° F., and when the thermometer records a temperature of 600° F. the flame shall be removed. The distillation shall be continuous, and the oil shall come over at a rate of one to two drops per second.

MELTING POINT.

A clean shaped ½-in. cube of the material shall be formed in the mold, placed on a hook of No. 12 (B. & S. gage) copper wire, and suspended in a 600 c.c. beaker so that the bottom of the cube shall be 1 in. above the bottom of the beaker (a sheet of paper placed on the bottom of the beaker and conveniently weighted will prevent pitch from sticking to the beaker when it drops off). The cube shall remain five minutes in 400 c.c. of freshly distilled water kept at a temperature of 40° F. before heat is applied. Heat shall be applied in such manner that the temperature of the water shall be raised 9° F. each minute. The temperature recorded by the thermometer at the instant the material touches the bottom of the beaker shall be the melting point.

FREE CARBON.

The free carbon shall be determined by making a hot extraction of 5 to 10 grams of material with c. p. tuluol followed by

c. p. benzol, or c. p. benzol followed by chloroform as solvents. The extraction shall be made in a Soxhlet, Knorr, Underwriters, or some other suitable extraction apparatus. The distillation of the solvent shall be continued until the washings run through practically colorless.

VISCOSITY.

The viscosity shall be determined in a standard Engler viscosimeter at 212° F. Sufficient material shall be placed in the viscosimeter to bring the surface of the liquid to a level with the tops of the three leveling points. The time required to discharge 100 c.c. shall be recorded as the viscosity.

Ugite.—Upon the thoroughly cleaned and dry concrete there shall be applied with a pressure distributor an application of Ugite A at the rate of $\frac{1}{10}$ to $\frac{1}{8}$ of a gallon to the square yard. At the expiration of at least two hours after the application of Ugite A, there shall be spread a thin layer of clean trap rock chips with a coefficient of wear of not less than 15 and which will pass a $\frac{1}{2}$-in. screen and be retained on a No. 10 screen. Upon the Ugite A and chips there shall be applied by a pressure distributor a coating of Ugite No. 3 at a temperature of from 225° F. to 250° F. at the rate of $\frac{1}{3}$ to $\frac{3}{10}$ of a gallon to the square. yard. Upon this application of Ugite No. 3 there shall be spread a layer of clean trap rock chips with a coefficient of wear of not less than 15 and which will pass a $\frac{1}{2}$-in. screen and be retained on a No. 10 screen, and which shall be lightly rolled with a 5-ton roller.

Upon this first application of Ugite No. 3 and chips there shall be applied with a pressure distributor a second coat of Ugite No. 3, as directed for the first application, at the rate of $\frac{1}{3}$ to $\frac{3}{10}$ of a gallon to the square yard. The second application shall be covered with a thin layer of clean hard trap rock chips with a coefficient of wear of not less than 15 and which will pass a $\frac{1}{2}$-in. screen and be retained on a No. 10 screen, and which shall also be lightly rolled with a 5-ton roller.

SPECIFICATION FOR UGITE A.

Specific gravity at 25° C.	1.09–1.12
Solubility in carbon bisulphide, at room temperature	Not less than 97 per cent
Viscosity in Engler viscosimeter, first fifty c.c. at 40° C.	60–100 in.
When 100 c.c. are distilled in a 250 c.c. Engler flask according to the method proposed by the American Society for Testing Materials, it shall show the following fractions by weight:	
Start to 170° C.	Not more than 3 per cent
Up to 235° C.	" " " 20 "
Up to 270° C.	" " " 37 "
Up to 300° C.	" " " 50 "
Melting point of residue (Cube Method)	Not more than 60° C.

SPECIFICATION FOR UGITE NO. 3.

Specific gravity at 25° C.	1.15 and 1.175
Solubility in carbon bisulphide, room temperature	Not less than 97 per cent
When tested in N. Y. T. L. Float Test at 100° C., the float shall sink in	20–24 in.
When 100 c.c. are distilled in a 250 c.c. Engler viscosimeter according to the method proposed by the American Society for Testing Materials, it shall show the following fractions by weight:	
Start to 170° C.	Not more than ½ per cent
Up to 235° C.	" " " 3 "
Up to 270° C.	" " " 12 "
Up to 300° C.	" " " 25 "
Melting point of residue (Cube Method)	Not more than 65° C.

Asphalt Cut-Back.—Upon the thoroughly cleaned concrete shall be placed with a pressure distributor a bituminous paint coat of $\frac{1}{8}$ gallon to the square yard—the materials and method conforming to that specified in the standard specifications.

Not more than 24 hours nor less than 6 hours after applying the paint coat, a second application shall be laid. This second application shall be the same as the first, except that the proportion of naphtha shall be 35 to 40 per cent and the penetration of the asphalt between 70 and 80. One-third ($\frac{1}{3}$) of a gallon to the square yard shall be used on this second application.

After about two hours there shall be evenly spread on the

bituminous material dry clean trap rock chips, graded in size from $\frac{1}{8}$ in. to $\frac{1}{2}$ in., in an amount from 20 to 30 lb. to the square yard, and rolled with a light steam roller until thoroughly compacted.

Unionite.—Binder: After the concrete has been prepared in accordance with paragraphs 262 to 276 inclusive, and has developed hard set, and just prior to placing the wearing surface, the base shall be thoroughly cleaned of loose or foreign material by sweeping with wire brooms and then covered with Unionite binder, consisting of equal parts by volume of asphaltic cement complying with paragraphs 243 and 244, and having a penetration of 55 to 65 at a temperature of 77° F. with a Dow penetrometer using a No. 2 needle and a solvent of one of the light hydrocarbons; the mixture when ready for application shall have a gravity of from 17 to 30 Beaumé at 77° F.; in all cases this binder shall be sufficiently fluid to carry the bitumen into the pores of the concrete before the solvent body evaporates and to leave a coating of bitumen on the concrete surface upon evaporation. The binder shall be applied either hot or cold, by an approved pressure distributor, as may be required, at the rate of $\frac{1}{8}$ gallon per square yard.

Wearing Surface.—After the solvent has evaporated from the binder, the wearing surface not exceeding $\frac{1}{4}$ in. in thickness after compression shall be spread. The wearing surface shall consist of rock asphalt or its equivalent especially prepared, $\frac{1}{4}$-in. crushed stone and Unionite asphaltic cement in the proportions of $47\frac{1}{2}$ per cent of rock asphalt or its equivalent, $2\frac{1}{2}$ per cent of Unionite asphaltic cement and 50 per cent of $\frac{1}{4}$-in. crushed stone previously coated with Unionite asphaltic cement. The Unionite asphaltic cement shall at all times be in such proportions as to make the wearing surface self-healing.

Asphaltic Cement.—The Unionite asphaltic cement shall consist of equal parts of benzol 28.5 to 30 gravity and asphaltic cement having a penetration of 55 to 65 at a temperature of 77° F. and complying with paragraphs 243 and 244, dissolved together either cold or heated from 190 to 230° F., after which the solvent shall be evaporated.

Stone.—The crushed stone shall be clean, hard trap rock with a coefficient of wear of not less than 15 or limestone with

a coefficient of wear of not less than 10, which will pass a $\frac{1}{2}$-in. screen and be retained on a No. 10 screen.

Preparation.—In preparing the wearing surface, the rock asphalt or equivalent material and the Unionite asphaltic cement in the proper proportions shall be first mixed either by being heated together or mixed cold. The crushed stone, which shall be heated or dried to a temperature not exceeding 300° F. and then thoroughly coated with Unionite asphaltic cement in a mixer approved by the Chief of the Bureau, shall then be thoroughly mixed in equal proportions with the rock asphalt or its equivalent and the Unionite asphaltic cement previously mixed until the mixture is uniform throughout.

Placing.—The material shall not be dumped directly on the concrete base, but shall be dumped on a suitable dumping board and then spread upon the prepared concrete base by suitable means to the required thickness, and immediately compressed by a steam roller weighing not less than 8 tons nor more than 10 tons. The rolling shall be continued until the resultant wearing surface is thoroughly compressed, after which a thin layer of trap rock chips passing a $\frac{3}{8}$-in. screen, free from dust, thoroughly coated with asphaltic cement before application, shall be spread upon the surface and then rolled. The wearing surface is to be laid at a temperature of from 225 to 300° F.

21. *Maintenance Guarantee.*—The contractor will be required to maintain the work done under these specifications and contract for a period of 3 years from the date of completion and acceptance by the city, with the exception of the bituminous wearing surfaces upon which no maintenance guarantee will be required.

22. *Time Allowed for Completion.*—The time allowed for the completion of this contract is 45 consecutive working days and shall be taken to mean that each and every portion of the work shall be completed within that time with the exception of the application of the bituminous wearing surfaces.

After the completion of all the work except the bituminous wearing surfaces, the contractor will be entitled to receive an estimate of 100 per cent of the amount earned.

The bituminous wearing surfaces shall be applied within 10 days after notice from the Chief of the Bureau to begin the work.

DISCUSSION.

Mr. Chapman. MR. CLOYD M. CHAPMAN.—Did I understand that the seventeen sections that showed the cracks through the center showed longitudinal cracks only? And I would also like to know whether the width of the roadway was 16 ft.

The President. THE PRESIDENT.—I understand the cracks were midway between the joints.

Mr. Ferguson. MR. LEWIS R. FERGUSON.—I was interested in knowing whether those cracks were longitudinal or transverse. I understood that they were longitudinal.

You will note that this concrete road was built over an old macadam road. As a rule, an old macadam road has an exceedingly high crown and in preparing it for concrete the first thing to do is to scarify the center of the road, remove the crown, and build up the sides so that a flat sub-base is secured. Unless great care is exercised, the sides are not as thoroughly compacted as is the center of the road, and there is a tendency for the mortar from the concrete to flow into the rather loose stone at the sides. This really acts as an inverted curb which prevents the concrete from contracting freely when it shrinks; and there is a tendency to crack longitudinally in the center of the road. Wherever an old macadam road is to be replaced by a concrete road, particular care should be exercised to roll the shoulders thoroughly, so that there will be no adherence between the concrete slabs and the old macadam at the shoulders.

Mr. Collings. MR. W. A. COLLINGS.—Did I understand that there was reinforcement in this road? I have reference to those sections in which the cracks appeared.

Mr. Fish. ASSISTANT SECRETARY FISH.—There were longitudinal cracks in seventeen of the thirty-five sections.

Mr. Collings. MR. COLLINGS.—Were those sections reinforced?

Mr. Fish. ASSISTANT SECRETARY FISH.—It does not say.

Mr. Kuelling. MR. H. J. KUELLING.—I would like to add just a word. We have built at least forty miles on old macadam, and we do not own a roller. With very few exceptions, however, we have

no longitudinal cracks. That has been our experience. Now, one thing regarding reinforcement. It is a thing that I think may be rather theoretical, but I think we will come to it. We will ultimately build a concrete road that will wear uniformly all over. That is what we are striving to do, and if we do, we are ultimately going to wear down to this reinforcing, and in my opinion it is going to develop a series of tacks with which to puncture automobile tires. Mr. Kuelling.

MR. JOHN W. MUELLER.—I want to give some evidence on the question of reinforcement in pavements that have been examined, where reinforcement has been used and where no reinforcement has been used. Where transverse expansion joints have been used the pavement showed a greater percentage of longitudinal cracks down the center than transverse or diagonal cracks, showing that there is need of something in the top of the slab at the center. Mr. Mueller.

THE CONSTRUCTION OF INTEGRAL CURBS.

By Charles E. Russell.*

All street pavements call for some form of curb and gutter, the cost of which to property owners usually amounts to from 45 to 90 cents per linear foot of street frontage, an expenditure often equivalent to 25 per cent of the cost of the pavement proper.

The cost of a proposed type of improvement often eliminates it from consideration and forces property owners to substitute an inferior type. There have been numerous cases where concrete pavements have been rejected for inferior and cheaper pavements when the property owners would gladly have accepted concrete if it could have been reduced 10 or 15 per cent in cost. This reduction in cost can be made by the adoption of the integral concrete curb, that is, one molded as a part of the pavement. During the past year successful demonstration has been made that integral curb reduces the cost at least 60 per cent for a 6 by 6 in. curb projection, while larger saving can be shown for smaller curbs and for gutter depressions. This being true, the integral curb deserves thought and investigation by engineers and others interested in paving work, even though they do not immediately recognize its merits.

During the past year several distinct types of curb and gutter were built successfully, each type designed to suit the scheme of landscape and local conditions. Fig. 1 shows the designs of curb on pavements at Highwood, Glencoe, Winnetka, Highland Park and Geneseo, Ill.; Kimberley, Wis., and Indianapolis, Ind.

The types of curb or rather gutter built at Geneseo and Winnetka, Ill., are well adapted to boulevards, park systems, suburban residence streets and lanes. These may be formed by shaping the ends of the strikeboard to the desired curvature. Cost can be estimated on the basis of additional square yardage of pavement, which generally amounts to from 3 to 5 cents per

* City Engineer, Highland Park, Ill.

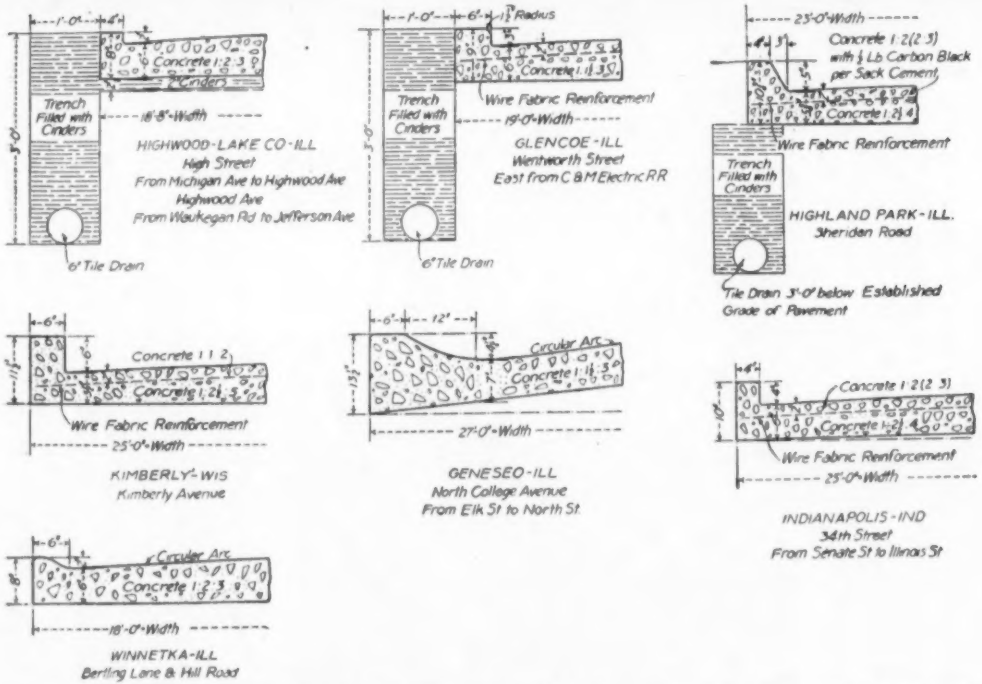


FIG. 1.—TYPES OF CURBS AND GUTTERS, BUILT INTEGRAL WITH CONCRETE ROADS AND PAVEMENTS.

lin. ft. of curb, when the cost of curb joint construction, including filler, is deducted.

That type of curb built on Sheridan Road at Highland Park, Ill., last season is the kind that would be suited to the average street. More concrete is required and a curb form must be used. Cost would be estimated at about 18 cents per lin. ft. of curb, which was about the actual cost of the Sheridan Road work.

Integral curb being a part of the pavement and composed of the pavement concrete mixture, which is of a rich mixture, rein-

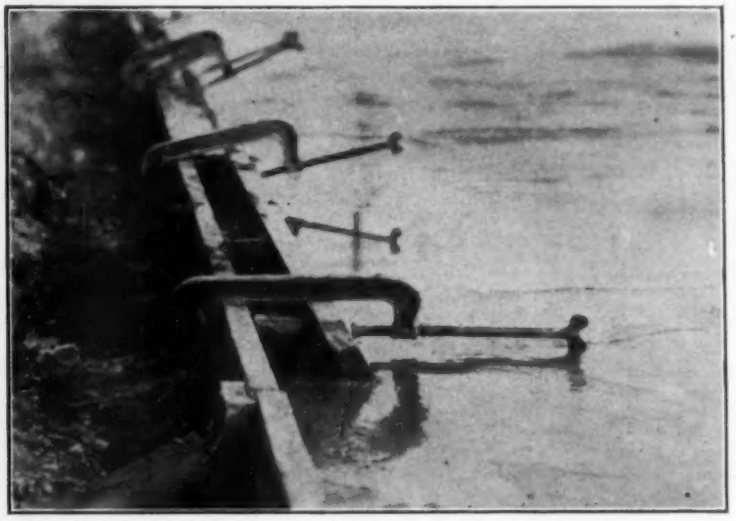


FIG. 2.—METHOD OF CONSTRUCTION OF INTEGRAL CURB AT HIGHLAND PARK, ILL.

forced by turning the pavement reinforcement up into the curb form, naturally results in a curb stronger than the average, and such construction cannot tip over or be forced out of alignment. It serves its purpose as a curb without doubt, and as well as any other type. An objection which has been advanced is that the integral curb is difficult to construct. Such objections are common to all new types of construction until contractors become familiar with methods, and therefore should in no way discredit the integral curb; in fact, the manner in which the problem was handled on the first jobs of this kind indicates that a satisfactory

and economical method of construction can be evolved. Fig. 2 shows the method of construction used very successfully at Highland Park, Illinois.

The essential requirements for the construction of integral curb are complete bond with the pavement, perfect alignment, good surface finish, clean joint coinciding with the pavement transverse expansion joint, and simple, inexpensive forms. When forms are devised which will meet with the above requirements there can be no objection to the integral curb.

Should each contractor, without previous knowledge or experience, endeavor to construct integral curb with forms of his own devising, it would probably be some time before perfectly satisfactory integral curb would be built to any extent. In the meantime, this desirable economic construction would be discounted or discarded. If, on the other hand, we place before those who are inexperienced a form which at least has some merit and which is designed on the fundamental principles stated herein, they should be better able to construct a more satisfactory job and at a more reasonable price; furthermore, each time a form is used some improvement will be made in it and it will be but a short time before the best forms are evolved and then the integral curb will become a standard with concrete pavement.

A design for integral curb forms is shown by Fig. 3. This is presented as a suggestion and it is hoped that it may be of help to those in this field of construction and that each one who is interested in integral curb will study the design and improve upon it.

Taking up the essential requirements of integral curb construction as previously given, we will not analyze them in connection with the suggested forms. For economic construction the curb must be made of the concrete of which the pavement is composed. Such concrete will be of quaky consistency and probably of the proportions 1:2:3 with the coarse aggregate up tp $1\frac{1}{2}$ in. in size. Pavement side forms are staked into position, concrete dumped between them and then struck off, just as in any concrete road work. Within fifteen minutes after the pavement is struck off the curb forms are set and filled. Complete bond is obtained by roughening the concrete at the bottom of the curb form by running a mason's trowel or a stick along through

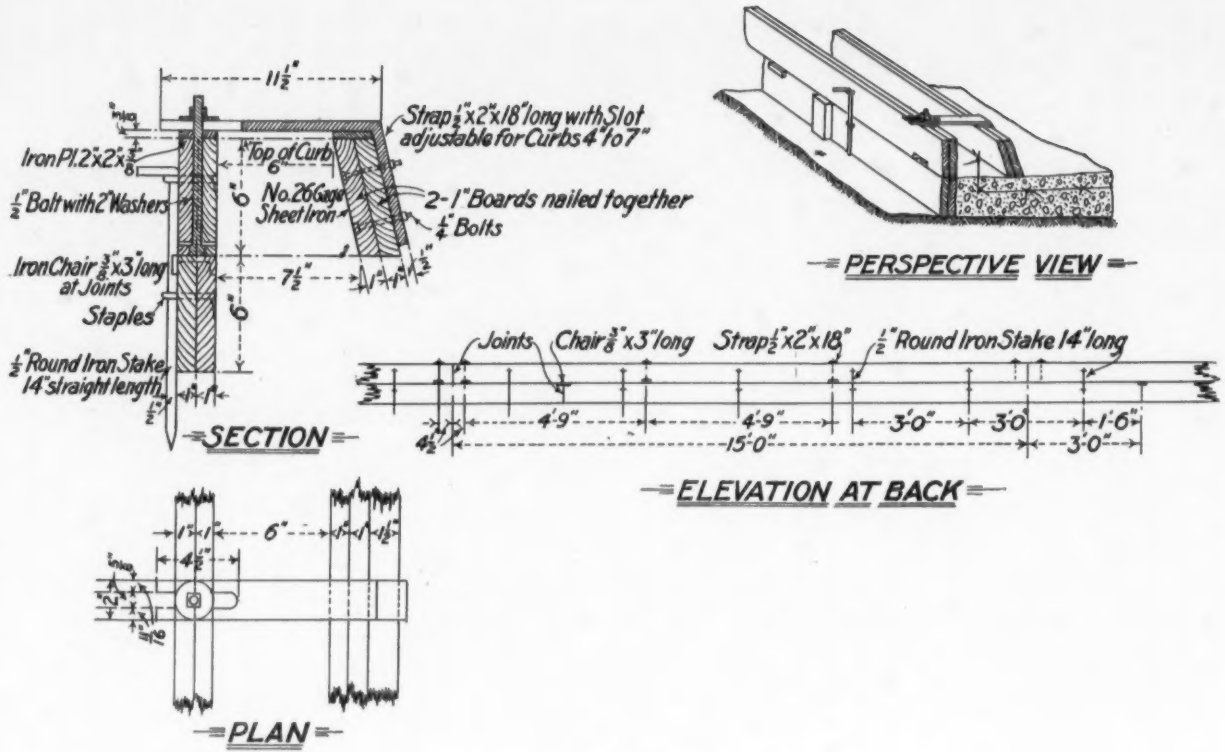


FIG. 3.—FORMS FOR INTEGRAL CURB.

it just before the concrete fill is made. Pavement reinforcement turned up into the curb also assists in strengthening the bond. The form for the back of curb is set upon the top of the pavement form and held snugly to it by pins run through staples in both forms and driven into the ground. The front form is held to the back one by adjustable iron strap clamps which permit perfect alignment of the front form after set up in place. Warping of forms is also minimized by using 1 by 6 in. lumber nailed tightly together with nails clinched.

When the concrete fill is made it should be worked to get a compact mass. This is best done by spading it with a shovel, after which a mason's trowel or a blade similar to a corn-harvesting knife should be run along against the front form to cut the coarse aggregate away from the form and thus work the mortar to the face. The front form is lined with sheet iron so that a smooth face is obtained without further troweling. The top can be edged and finished readily while the forms are in place. No work will be done on the curb after the forms are removed except touching up defective spots.

Expansion joints are required in the curb at and coinciding with transverse expansion joints in the pavement. These must be exactly over the joints in the pavement, for if they are not the curb at these places will be likely to spall off. This can be readily accomplished by backing up the joint filled on the off side with a bulkhead which can be slipped out after the concrete fill is made on both sides of the joint.

Since a concrete of quaky consistency is to be used, forms must be left in place at least three hours. This will necessitate having on hand about two or three hundred linear feet of forms. These, however, are of simple construction and inexpensive. Fifty dollars will cover the cost of forms with which to lay at least 600 lin. ft. of curb per day.

Admitting that most of us are likely to find objections to this new type of curb, we cannot conscientiously cast the idea of integral curbs from our minds, because its adoption will create a saving of approximately 60 per cent of the cost compared with independent curb.

DISCUSSION.

Mr. Kuelling.

MR. H. J. KUELLING.—I would like to ask Mr. Russell if he pours the curb at the same time as the rest of the pavement; and also whether he has any trouble striking off his road when building the curb?

Mr. Russell.

MR. CHARLES E. RUSSELL.—The road is first struck off before putting on the inside form. After the road is crowned, and before it is floated, the inside form is placed, and then filled with the same mixture of concrete as is used in the top course of the pavement. That is smoothed off, and after it has set sufficiently it is troweled.

CONCRETE ROADS AND FROST ACTION.

By Andrew M. Lovis.*

There are four distinct features to be considered in road construction: the alignment, the grade, the foundations and the surface. We sometimes hear comparisons made of the relative value of these factors, but in the consideration of what is sometimes called "a perfectly good road" we will find that all are necessary and equally important. In the order of their construction, the value of each depends upon the integrity of the preceding work. Almost an infinite variety of surfaces may be used on roads, and some variations may be made in the locations and grades, but whatever may be the alignment, grade or surface, we must try to make permanent the foundations.

There has been a belief that the foundations under a concrete road may be neglected, and in fact it has been believed that concrete may be laid with perfect safety on almost any kind of soil without danger of bad effects from frost action. There have, however, been many experiences which prove that such is not the truth, and most concrete road-builders are now of the opinion that the subgrade is to be constructed quite as carefully for concrete as for a macadam or gravel surface, and this is substantially the opinion of the Committee on Subgrades as expressed in their report at the National Conference in Chicago last year.

It will be found very difficult to make any standard specifications for subgrading which will not be a source of danger, rather than of safety, in practice, the danger being that the inexperienced engineer may follow literally the rule given, even though the physical conditions require special treatment. The construction of the subgrade for a macadam or gravel road has always required more special experience on the part of the engineer than any other subject connected with the work, after the location and grade lines have been determined. In Massachusetts we have learned something of this subject only after having made many mistakes, especially as a result of not having enough volume and

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depth of good material in the subgrade. It is doubtful if, later, in the full knowledge of the case, we can cite a place where too much material was used. Economically wiser construction, during the past eighteen years, would have involved a different type and a greater amount of material in the subgrade than was practiced, especially in the earlier years.

The side-drain type of construction was used for about ten years, and was abandoned, and what was called a V-drain was adopted. This drain consists of a stone fill of cobbles, in sizes of 8 in. and less in their longest dimensions, and in bad soils was constructed 18 in. in depth in the center and 6 in. at the sides, under the full width of the macadam, giving, for a 15-ft. road, about one-half a cubic yard of stone fill per lineal foot. Good gravel, instead of cobbles, has been used in the same way, with satisfactory results. This type of drain has been changed, of recent years, so that at present the stone fill or gravel is often placed on a level base. The important end to be attained is to overcome a tendency to irregular frost action and resultant disintegration of the surface. Our experience in Massachusetts on the greater value of this method of construction over the old system of side-drains is a positive one, and there need be no further basis of argument on this question. Disintegration from frost action has been overcome by this method more effectively than by the side-drain method, and at a very much less cost. In connection with this matter, it is important that the water be drained from under the road at intervals by means of blind drains.

The following is a copy, in part, of specifications for stone filling:

> At such places as the Engineer may direct, stone filling shall be placed. Excavations shall be made to the lines shown on the cross-sections. The stones to be furnished by the Contractor may be either wall stones or cobbles ranging in size from the smallest obtainable to those not exceeding eight (8) inches in their longest dimension, and the larger stones shall be placed at the bottom. . . . The stone filling shall be rolled with steam road roller to the satisfaction of the Engineer.

In 1913, in the town of North Andover, the Massachusetts Highway Commission built a concrete road for a length of about two miles. The concrete was put on an old turnpike between

Salem and Lawrence. In our preliminary consideration of the type of road to be used for this section, we proposed a macadam road with a 2-in. bituminous upper course of Bermudez Asphalt. As the sub-soil was exceedingly bad, it was proposed to put in about 8 in. of gravel under the macadam. When the preliminary estimate was made, it was found that the cost of subgrading was considerable, and made the total estimate for this construction high, and on that account it was decided to adopt a concrete road, as the estimate showed that the concrete road would cost less than the Bermudez road.

The cross-section for the road was such as would be used for a macadam road, with the same crown for subgrade and for surface section. This, however, was changed to a level cross-section for the subgrade before the work was finished. The road was $19\frac{1}{2}$ ft. in width. The concrete was 8 in. deep in the center and 6 in. deep at the sides. The mixtures of concrete were 1:2:4, and $1:1\frac{1}{2}:3$. The stone used in the concrete varied in size from $\frac{1}{4}$ in. to $1\frac{1}{2}$ in. The concrete was laid in one course, and a number of different brands of cement were used.

After the road was finished, cross-sections were taken at intervals of 50 ft., and marks were painted where the rod had been held for levels at the center and sides. In the winter, after a continuous cold spell, these levels were taken again at the same places that the originals were taken, and again in the spring, when the frost was entirely out of the ground. By this means it was possible to know exactly how much the surface was raised by the action of the frost, and to observe carefully the raising of the road and its relation to the cracking of the surface. A diagram of the road was plotted, and notes were made which indicated, in tenths of a foot, the amount of the lifting of the surface. Also, on the same diagram, the cracks on the road were shown. These cracks were, as a rule, longitudinal, and were a little to the right or left of the center. In nearly every instance the evidence of this diagram is that where no gravel was placed beneath the concrete or where the concrete was not reinforced, the cracks developed on the road proportionately to the amount of the frost action. This seemed to be invariably the condition, as in no instance did we find these longitudinal cracks well developed except where the frost had affected the road considerably, and it

also appeared that in no instance was the frost action severe without the accompanying cracks, except on certain sections of the road where gravel had been placed in the subgrade under the concrete. We found, also, that the reinforcement of the road with steel rods had a considerable but not complete effect in offsetting the development of cracks, even where the frost action had been severe.

It may be inferred from our experience on this road that it is an immensely important matter to see that the subgrading is ample and as permanent for this sort of structure as if we were constructing either a macadam or a gravel road.

In reference to the question of whether we may assume that it is possible to reduce the amount of material under a concrete road, and use less than we would if we were constructing a macadam road, I have endeavored to get the opinion of several men who have had considerable experience on concrete construction. The opinion of one was that it was impossible at the present time to determine how much may be saved in subgrading, but he writes:

> I should be inclined to say, on an average the cost of subgrading under concrete roads might be reduced from 25 to 50 per cent.

If this were adopted in theory, it would be safe, in making a preliminary estimate for a road of this character, to reduce the amount of the loose stone or gravel under the concrete by one-third.

Mr. Austin B. Fletcher, Highway Engineer of the State of California, in reply to this question, says:

> With the thin work, mostly not over four inches, which is being done so generally on California State highways, there is no saving in cost in the subgrade, and in my opinion, the cost is considerably increased because of the extraordinary care it is necessary to take in getting a firm, hard, subgrade. I hardly know how this would work out in the case of a thick concrete base but I would hesitate to scrimp on the character of the subgrade even if six or seven inches of concrete were used. It is true that the concrete bridges over small inequalities in the subgrade, but I do not think that one should place too much reliance on this property of the concrete.

In the first part of this paper it was stated that the old side-drain type of construction was abandoned in Massachusetts over

ten years ago, and a rough stone fill was deposited directly under the macadam, and the results were much more satisfactory than those we had obtained with the side-drain type of construction. It seems evident that this experience with macadam roads should be applied to the construction of concrete roads as well, and the road engineer should not place too much confidence in the side-drains to provide against any disintegration of the surface of the road. It is not meant by this statement to imply that the side drains have no value, but the point is that the stone or gravel filling under the macadam or concrete will be more efficacious and less expensive, and the virtue of it will become apparent after a number of years have elapsed, because it has been found in this state that only after a term of years was it realized that the side-drains were becoming failures.

In conclusion, it is plain that it is not wise to neglect the foundations under a concrete road. If the engineer has had experience in determining the proper amount of material to be placed under a macadam road, he may assume that somewhat less will suffice under a concrete surface, but with our present knowledge of this subject he will be careful not to invite a failure by using too little material. It is not always possible to obtain good gravel of cobbles for making a foundation in the immediate neighborhood, but it will be best to import them rather than to take a chance with inferior material. The sand or stone should be placed for the full width of the concrete slab.